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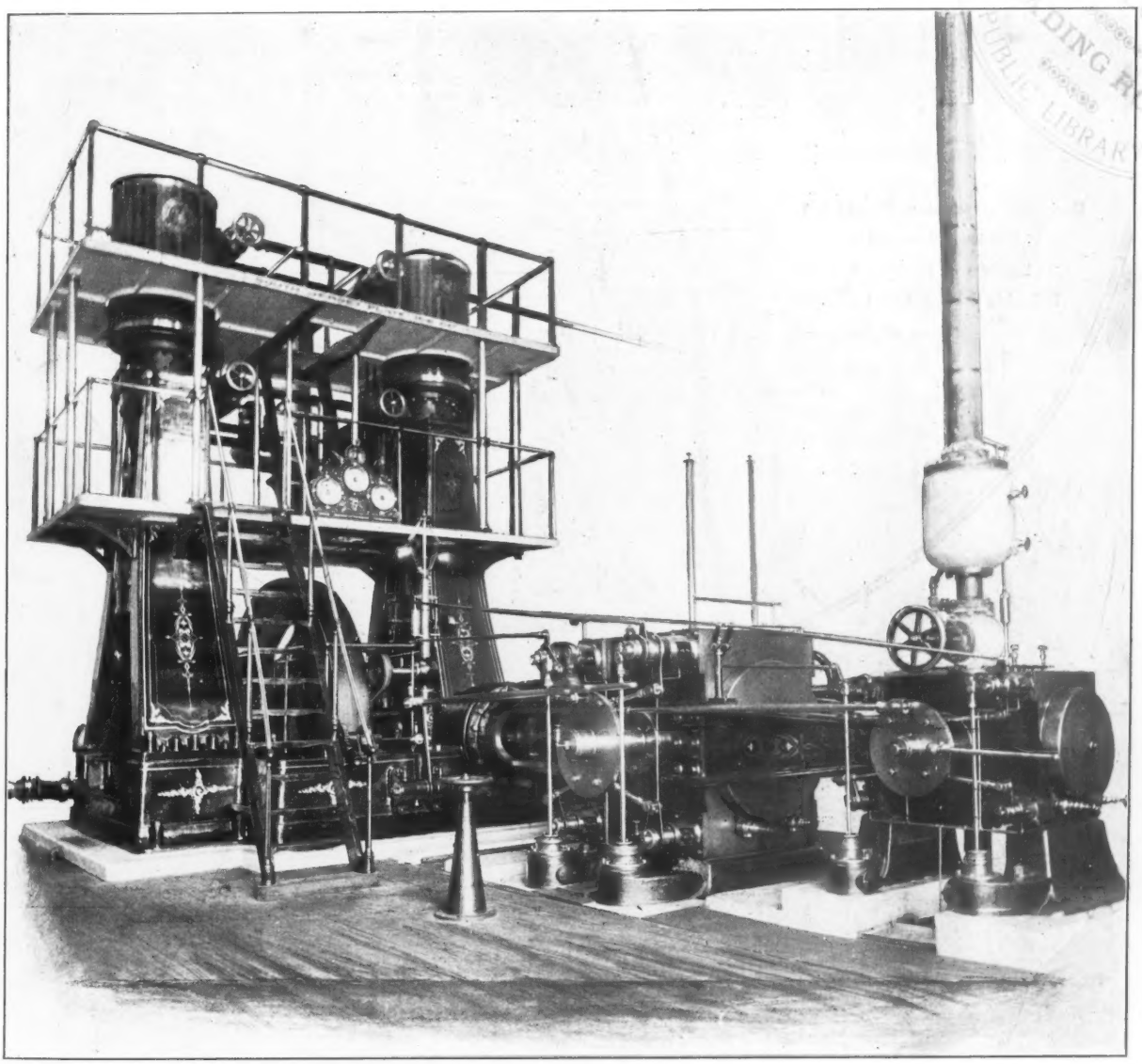
The PRACTICAL ENGINEER

Vol. VI. Philadelphia, September, 1902. No. 8.



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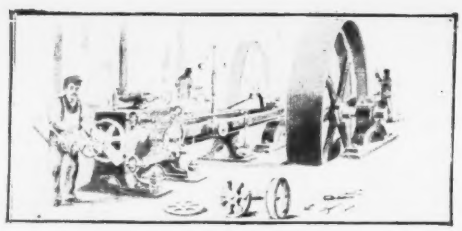

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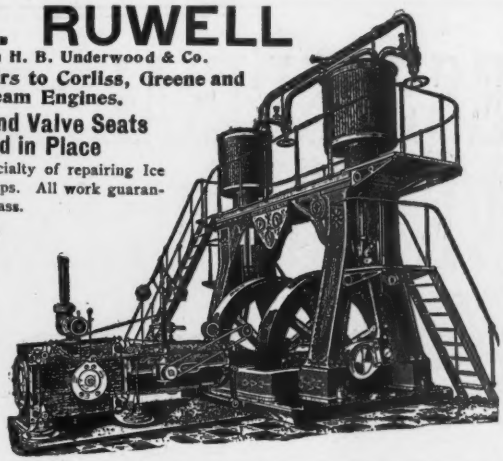

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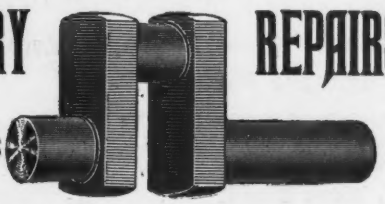

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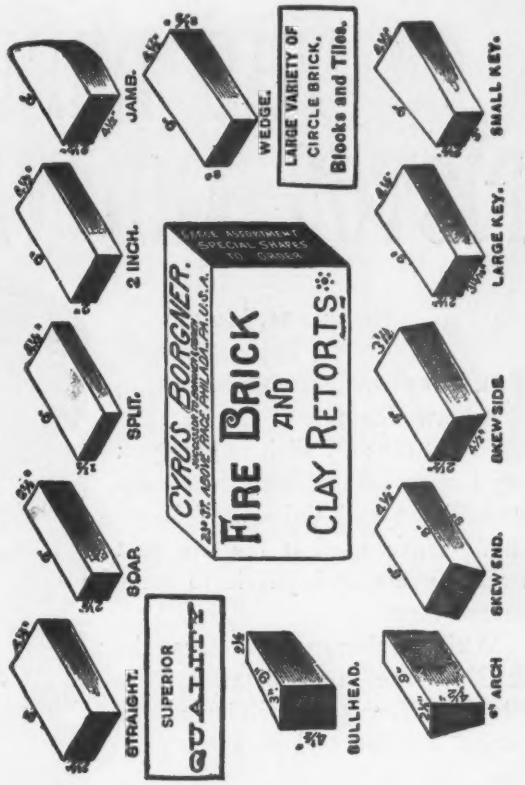

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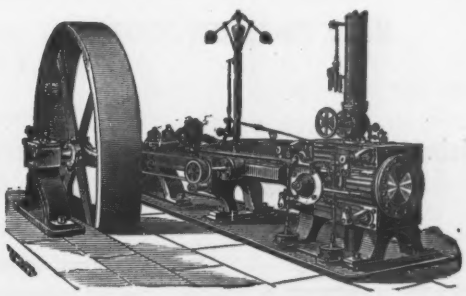

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The Practical Engineer

THE
OFFICIAL ORGAN
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AMERICAN ORDER
OF STEAM ENGINEERS

Devoted to the Interests of Stationary Engineers.

VOL. VI. PHILADELPHIA, SEPTEMBER, 1902 No. 8

Heat and its Transmission

The theory of combustion and the generation of heat in the furnace of the steam boiler has been so fully and so exhaustively treated in recent issues of the technical journals that it is doubtful whether there are any who do not have a practical understanding of these phenomena. However, the generation of heat is one thing, while the application of that heat to desired ends is wholly a different matter.

In the steam boiler, a furnace either inside or outside the shell forms the chamber in which the actual generation of heat takes place. After that, the main point is to transfer that heat to the water in the boiler with the least possible loss, and in the shortest possible time.

There are four ways in which the heat is propagated from the bed of coals and the hot gasses of combustion to the water, and they are: First, radiation; second, conduction; third, convection; and fourth, contact.

By radiation is meant the passing of heat from one body to a colder one without any contact or without the use of any visible medium. Heat which is transmitted in this manner is known as radiant heat. When the fireman opens the door of his furnace to feed his fires, waves of heat surge forth and envelop him. There is no current of hot gasses toward the fireman which could carry this heat to him, for he can see the dust being sucked into the open door by the draft, and he knows from that that the air currents are moving away from him in the direction of the furnace. Yet he feels the intense heat of the furnace.

This is radiant heat. It does not heat the air in front of the boiler. For if the temperature of the air be taken before opening the door and again immediately after closing it, no variation will be found. Hence the air did not carry this heat. It was transmitted by the ether, a medium which fills all space, and through which heat, light and electricity are carried or conducted.

The amount of heat which is radiated from the burning fuel will depend upon the condition of the fire or upon its state of incandescence. If the fire has been freshly fed so that a layer of raw fuel covers the bed of coals, the radiation will be much less than it would be if the fire were burning brightly and the bed of coals glowing at a white heat.

For the temperature of the source of heat governs the intensity of the radiated heat. Therefore, if at one time the bed of coals is at 2500° F. and at another time only 1250° F., it may be correctly judged that the intensity of the radiation is only half as much in the latter case as in the former.

There is another well-defined law governing the radiation, and it relates to the distance from the source of heat. In the case which we have assumed, the bed of incandescent fuel is the source of heat, and the boiler plates form the surfaces upon which this radiant heat manifests itself, or becomes sensible, so to speak. This means that the distance from the grates to the plates of the boiler has to do with the intensity of the heat radiated.

And this is true enough. The law governing this case, which has been conclusively proved, states that the intensity of heat radiation varies inversely as the square of the distance from the source of heat. For example, let us assume two cases, in one of which the bed of coals is one foot from the bottom plate of the boiler, and in the other of which the coals lie two feet below the shell. Taking the condition of the fire to be the same in both instances, we should have only one-fourth the radiant heat in the latter case that we had in the former, for the reason that the distance between plate and course of heat has been doubled.

As stated previously, the condition of the fire has a great influence upon the radiation. But it has been found that with a good, even bed of live coals and the fire burning

brightly, about 50 per cent. of the heat transmitted to the boiler from the furnace is accomplished by radiation.

The heat which is radiated from the fire strikes the boiler plates first and heats them. These plates are further heated by contact with the hot gaseous products of combustion impinging against them on the way to the chimney.

The boiler shell having now had its fire surface heated to a high temperature, transmits its heat through the plate to the inner surface where the water, by contact, takes up this heat. This passage of heat from one surface of the plate to the other, through the iron, is known as conduction.

The heat, transmitted by contact to the water, is now carried throughout the liquid by convection. The particles of heated water next the shell expand under the action of heat and their specific gravity becomes less. As a consequence they rise, and the heavied particles of colder water sink down and take their place. These are in turn heated and give way to other cooler particles. This action continues as long as heat is applied, forming a continuous circulation, by means of which the particles are thoroughly mingled and the heat transferred to all parts of the water in the boiler.

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The Isthmian Canal and its Relation to Steam Engineers

Probably very few of the steam engineers of the country gave more than a trifling thought to the passing of the canal bill which, a few days ago, was signed by the President, thus making the project of cutting a deep water-way through the land joining North and South America a certainty; yet there has been no public or private enterprise in years which promised so much to the engineers' profession as does this gigantic work.

The manufacturers of this country have not yet waked up to what the building of this canal means to them. They don't realize the great amount of machinery, tools of all kinds and construction material that will be required.

However, unprecedented activity is beginning to be manifested by those who will be beneficiaries of the canal construction. During the month, a large delegation representing all the dredging interests of the United States, met in Washington, D. C. Another delegation, representing the transportation interests, were in session there at the same time. Representatives of other interests have also met and formed their plans.

At the very beginning of construction several great electric lighting plants must be installed, so that the work may progress by night as well as day. The manufacturers of electric lighting apparatus have before them such an opportunity as has never been seen.

Along the twenty-three upper levels the canal excavating must be done by steam shovels. There will be heavy rock work, involving the use of drills, blasting material, donkey engines, structural iron work for bridges, steam cranes and almost untold articles of machinery, which will keep each specialist employed with furnishing material to the government, presumably at top-notch prices.

The canal will have huge locks of concrete masonry. These will require hundreds of thousands of tons of cement. Great quantities of hewn granite will be needed for the locks. There will also be necessary especially made steel machinery for operating the gates to the locks.

The Bohio dam alone will give fortunes to manufacturers. This will be the largest dam ever proposed by engineers in the world's history. It is to have a foundation of caissons, sunk to a depth of more than 100 feet, by the pneumatic process. This will necessitate the making of special machinery and great air pressure plants. In addition, the caissons must be made. They will be square, of heavy steel plates.

Millions of dollars will be expended in feeding and clothing the army of workmen employed on the canal from eight to twelve years. Canned goods of all descriptions and food supplies of every kind will be purchased in this country. Certain forms of clothing, boots, shoes and rubber goods will be needed. Medical stores will give even the druggists a chance.

Not only will there be increased opportunity for the engineer in our home districts during the construction of this vast quantity of material, but the work itself will require the aid of thousands of men skilled in every phase of steam production and consumption. It is true that the country, through which the work will be carried on, has the name of being unhealthy, but that is a feature which American sanitary conditions and ingenuity will overcome. Hence we may look for a demand for steam engineers for this enterprise which will be unprecedented. To the young man in the profession there is unlooked for opportunity to rise.

It will be well for our engineering classes to start right in now to study up this proposition, for to no other profession or trade will so much of the money spent, revert, as to the steam engineer.

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Philadelphia Councilmen Will "Burn" Smoke

The city of Philadelphia may soon have enacted a law compelling the application of some sort of smoke preventer to all steam boiler furnaces; this is as it should be, but, according to reports current, the thoughtful gentlemen occupying the City Councilmen's chairs intend, in order that the dear public shall not be imposed upon by manufacturers of worthless smoke consumers, etc., passing a law to prevent the public from applying any apparatus to their boilers other than they (the Councilmen) shall determine upon. This, there is no doubt in the world, they are competent to do, for if anyone has a more thorough knowledge of engineering (that is engineering the Philadelphia political machine) than the councilmen who have the project in hand, we don't know it. Hence, we may now rest assured that the smoke nuisance is soon

to become a thing of the past, or at least as soon as it shall be possible for the manufacturer, of the design of machine chosen, to attach the same.

So far as we can learn, with that tender regard for the comfort of the citizens and the usual desire to save others trouble and worry, the councils appointed a committee to choose the design of the appliance to be used with as little fuss as possible, at least that must be the object in view, because no one has a word to say in the matter other than this committee, and they are sawing wood.

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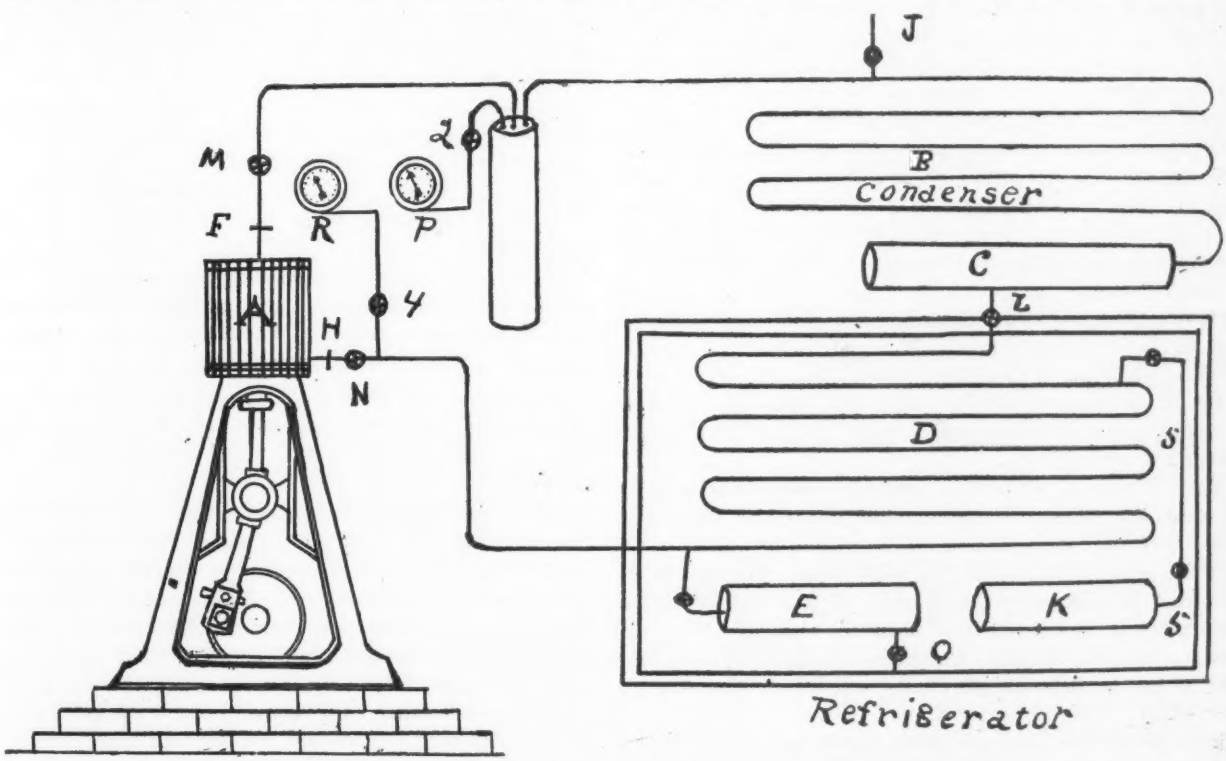
The Proper Method of Charging an Ammonia Compression Plant

The presence of air in the ammonia system of cold storage or ice plants is undoubtedly the source of much annoyance and trouble to the engineer in charge, but if the proper care is taken in the matter of applying the first charge, there can be little or no opportunity of air gaining admittance to the pipes. The trouble usually arises from lack of proper pumping out of the system at the start of the season. In order that the proper method of supplying the ammonia charge may be known correctly, included under this heading is a description of a charging system with illustrations. A careful study of which will no doubt be of value to those who are to a certain extent new to the cold storage profession, and possibly it will enlighten many possessing more mature knowledge of the business.



Upon completion of the erection of a nice-making plant, we find an engine with gas pumps attached for pumping the ammonia gas, the pump being not unlike air compressors; also a system of pipe work attached to both the discharge and suction side of the gas pump.

This system is complete within itself, that is, there are but three openings left to the atmosphere.

The first of these is a charging connection for permitting ammonia gas to enter (5) from the charging tank (K).

The second, on the top of the condensing system at its highest point (J), is for removing air which may from time to time enter while making changes in the ammonia system.

The third is usually at the lowest point in the system (O), connected to the trap E, attached to the refrigerating pipe system (D) for the removal of oil, water or dirt which may collect in the same.

On the completion of the plant, the connections at the discharge and suction side of the gas compressor should be opened, and the engine and compressor run until you are satisfied they are in working order.

When the engine and compressor work smoothly, close up the flange connections on the discharge at F, also the gas valve at N, leaving connections at H open; this allows the pumps to draw in air, and an air pressure to accumulate in the piping.

The object in this accumulating of air pressure is to test joints for leaks.

If no leaks are found, pump air pressure to about 100 lbs. per square inch, then stop until the heat generated in the compression of the air, which will be about 150 degrees, has passed away.

While your engine is stopped, make a careful examination for leaks, as it is absolutely necessary to have tight pipe work, for the loss of ammonia gas means the loss of ability to do refrigerating.

After allowing the machine to stand idle about one hour, start up again and pump up pressure to 200 lbs. per square inch, and again allow the machine to cool down. Continue this method of pumping pressures until you have a pressure of 500 lbs. per square inch, when the suction flange H should

be bolted tight and the valve N opened. This will give you a pressure of say 450 lbs. on all sides of the gas pump. At this time it will be found that the stuffing-box leaks a large amount of air.

As soon as you definitely determine that all joints around the compressor are tight, shut off the suction and discharge valves N and M, and allow the pressure to remain in the piping. The object of closing the two valves is to prevent the loss of air around the piston and stuffing-box.

The air pressure in the piping will fall as the air becomes cooled, or falling from a temperature of 100 degrees to 70 degrees F., pressure should fall about 23 lbs. per square inch, providing there are no leaks in the piping or joints.

While pumping a pressure on the coils, the return pressure gauge R, must be closed off at cock 4. These gauges are usually what is known as a combination gauge, recording both pressure and vacuum; in other words marking the condition from absolute pressure, which means the absence of atmospheric pressure

The high pressure can be noted on the gauge P, which is usually constructed to permit the indication of pressures as high as 500 or 600 lbs. per square inch.

If the system is found to be tight, pump the air out of the piping. Close the cock M on the discharge side of the gas pump and open the flange F, which will permit the discharge of the air. Open the valve N on the suction side and permit the air pressure to discharge.

When the pressure is at atmosphere open the return pressure gauge R and close off the direct pressure gauge by closing cock (2); the reason for closing this last gauge is, that it does not register below atmosphere, and if it is not closed the interior mechanism of the gauge will be injured.

Start the gas pumps and discharge the air at flange F. Care must be taken in doing this, for if any oil is discharged with air, which comes out in a spray like a fog, and it should come in contact with the light of a candle or of gas, there would be a sharp explosion, caused by the carbon of the oil mixing with the oxygen of the air and other elements, and do much damage.

Having pumped the air from the pipes until the combination or back pressure gauge R registers 26 or 28 inches vacuum, which would mean the removal of at least 90 per cent. of the air in the plant, attach a shipping tank of ammonia K to connection 5, and allow sufficient gas to enter to raise the pressure to atmosphere.

There is now 90 per cent. of ammonia gas mixed with 10 per cent. air. Close all connections, and pump the gas to pressure in the condenser and examine again for leaks.

If the work so far is found to be all right, open flange F, close cock M, and pump this mixture of gas and air to the atmosphere until there is 26 or 28 inches vacuum. This will leave 10 per cent. of the air and gas in the piping, but as 90 per cent. of this is ammonia, the charge would only have one per cent. of air.

Next permit the ammonia gas to flow in and fill the piping to atmosphere, which will force out what air remains in the compression chambers; then close up all pipe connections and the relief cock L and start water over the condensing coils.

Start the gas pumps and permit the gas to enter from the shipping tank, and pass through the refrigerating coils to the pressure side of the machine until it obtains sufficient pressure to liquify and deposit itself in the liquid tank C.

After a sufficient amount of gas is put in to properly charge the plant, it is ready for refrigerating or ice-making.

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Superheat and Superheaters

By H. CRUSE

In the following pages we shall give in brief outline the history of the superheating of steam. We shall also describe the salient features of the leading types of modern superheaters in operation.

Perhaps, however, for the information of those of our readers to whom, from lack of interest or of opportunity, superheat has remained an unstudied subject, it were well we gave precedence to an epitomized description of the method of its production, of its properties, and of its potency to develop the efficiency of steam in the transformation of heat into active energy or power in the engine cylinder.

There are at present two main methods in operation for the production of superheated steam; one we will briefly notice here, "en passant," as it is but little known, and its application has, hitherto, been restricted to small plants and for special purposes only. In this system the steam generator and the superheater form one continuous apparatus—a superheating boiler. There is neither a distinct water space nor a steam chamber, and the whole apparatus consists of one or more coils of piping of small bore. It is generally operated without water-gauge or safety-valve. The feed-water is pumped continuously in a fine jet or spray into one end of the coil, is flashed into steam immediately on entrance, and, as it travels upward through the coil, it acquires pressure, and is eventually superheated. Messrs. Serpollet and De Laval have both successfully employed this system in small units. In the generators of M. De Laval, the steam is raised to exceptionally high pressures—as high, we believe, as 3,000 lb. on the square inch.

In the second system, with the various applications of which we shall deal in this sketch, the superheater forms a distinct unit, extraneous to and independent of the boiler, with which, however, it is in close connection.

Saturated steam contains, at a given temperature, the maximum weight of fully evaporated water, and possesses the greatest possible density and pressure corresponding to such temperature.

When, by the continued accumulation of heat, the temperature of saturated steam in the boiler rises, so also in ascertained proportion do its pressure and density; its volume per pound weight, on the contrary, diminishes. If, however, this steam be wholly withdrawn from the boiler, thus removing it from immediate contact with the water from which it generated, and passed into a separate chamber, wherein, while it is subjected to further additions of heat, it has full freedom to expand, the temperature will rise without corresponding rise in pressure, but the density will diminish and the volume will grow as the temperature increases. Thus the change of circumstances under which heat is transmitted to the steam produces diametrically opposite effects. The margin of the temperature of steam thus reheated, above that normal to its pressure, is expressed in degrees of superheat, and the number of degrees multiplied by the specific heat of superheated steam

represent the "superheat" or excess heat necessary to effect the increase in temperature.

The specific heat, or the co-efficient of thermal capacity of saturated steam in process of generation in the boiler, is given as 0.305; i. e., an addition of 0.305 B. T. U. will raise the temperature of one pound of the co-existent steam and water through one degree Fahrenheit and proportionately increase the pressure of both.

The specific heat of superheated steam, at constant pressure, is approximately 0.4805; or, otherwise stated, 0.4805 B. T. U. is required to carry one pound of dry steam entirely removed from the influences of the boiler water through one degree Fahrenheit, with an increase in volume, but without any change of pressure.

In the process of superheating, the action of the steam is that of a gas under the influence of heat; the steam must increase either in volume or in pressure as the temperature rises, and, therefore, were the steam "bottled up" in a close receptacle while being reheated, the result would be a rapid increase in pressure. In the superheater the steam has freedom to expand as the heat is added, and the volume of steam per pound weight is increased in proportion to the rise in temperature; but the pressure does not rise above that of the saturated steam in the boiler. In practice, the superheater is an extension of the steam space of the boiler, with which it is always in open communication; it is, in fact, a loop, or series of loops, through which the steam travels on its way from the boiler to the engine cylinder, and the pressure in the boiler is the governing pressure of the two, and is limited by the boiler safety valves. In the cylinder of each displacement of the constantly moving piston causes a void which is immediately filled by the steam nearest to it, an equal volume, or weight, being simultaneously disengaged in, and liberated from, the boiler. The piston acts as a movable plug at the end of the steam pipe, and the continuous flow thus set up allows the steam in the superheater freedom to expand, in relation to the heat added to without reaction upon the motive pressure behind it. If, however, while the boiler and superheater are in operation, the out-let valve from the latter be shut, thus closing the steam "circuit" and stopping the flow, the volume will rapidly reach its maximum, and further additions of heat will induce proportionate increases in pressure. But the superheater is still open to the steam space of the boiler, and the columns being in unbroken contact with the boiler steam, they will be similarly subject to the influences of the boiler water, although to a less extent, and the superheating effect will be correspondingly reduced. On the other hand, the heat absorbed by the steam in the superheater, reacting upon the steam and water in the boiler, will increase the rate of evaporation of the non-combined generator, and any tendency to rise of pressure in the superheater will be averaged; and, although the temperatures of the superheated and saturated steams may continue to vary, their pressure will rise equally and at the same rate, until the blowing-off pressure is reached, when, by the lifting of the safety-valves, both superheater and generator will be relieved. Superheated steam is of necessity dry. Water cannot exist in contact with it, or in its presence; either the superheat will evaporate the moisture, or will itself be wholly absorbed and disappear, and this points to the first apparent advantage to be derived from superheating.

The steam from all large generating units, working at commercially economical rates of evaporation, leaves the boiler in a more or less "wet" state, never fully saturated and "dry;" now, whether the steam contain moisture in suspension, or "priming" water in more solid form, the first operation of the superheater will be to complete the evaporation of the moisture present, and thus to "dry" the steam, which, as it travels through the pipes, will develop into superheated "steam gas." This "steam gas," being absolutely dry, will yield up proportionately less heat by radiation in the pipes, when travelling from the superheater to the engine, than would the moist steam if supplied direct from the boiler. Again, loss of heat has the immediate effect upon saturated steam of causing a portion to be condensed, which, if the loss be accentuated, is quickly followed by a drop in pressure; whereas, with superheated steam, no condensation can take place until the steam has parted with the whole of its super (or added) heat and has thus fallen to the temperature normal to its pressure. There being no condensation in the pipes, friction is diminished, water-hammer is entirely removed, leaking joints are practically obviated, and the steam should if sufficiently superheated at the outset reach the engine starting valve dry, superheated, and at full boiler pressure.

In all but extreme cases an addition of 200 degrees of superheat will be found ample to carry the steam from the boiler to its work "dry" and superheated, thus ensuring that it shall there possess the full thermal efficiency due to the pressure, and that it shall enter the cylinder without previous condensation. For modern high-class plants, where the boilers are in close proximity to the engines, and where the loss of heat by pipe radiation is reduced to a minimum by careful lagging, the steam will enter the cylinder containing sufficient superheat to carry it to cut-off without initial and cylinder condensation, and it will reach that period of the stroke at which expansion begins dry, all steam, fully saturated, and with full heat energy, sensible and latent, corresponding to the pressure; the re-heating of the metals, the evaporation of the water of exudation formed upon them, and the application behind the piston, during admission, of the motive power of displacement exerted by the steam simultaneously forming in the boiler, will have been effected at the expense of the superheat present in the steam.

When by superheat the steam is carried dry to cut-off, the sole liquefaction in the cylinder being that due to work performed at the expense of the latent heat of the steam during expansion, the amount of heat required for re-evaporation during exhaust is reduced; the cylinder is maintained dry during the stroke; the final, and consequently the mean, temperatures of the metals are higher, and the heat interchange between the metals and the steam is considerably reduced; less heat or energy is abstracted from the incoming steam for re-heating, and the superheat being sufficient to effect this purpose, the full latent heat in the saturated steam is available for expansion.

Therefore, superheat provides extra heat for re-heating the metals, without initial and cylinder condensation, and without material drop in pressure; this extra heat also retards and minimizes liquefaction during expansion, and, by enabling more of the latent heat to be employed in doing useful work, adds to the power of the steam during this period; it thus increases the work efficiency per pound of steam in the cylinder and reduces the weight of steam required to effect a given work.

The higher the superheat, within certain practicable limits,

the greater the economy of steam, because the drier the steam at cut-off, the greater is the work that can be effected per pound of steam during expansion and the higher the final temperature of the metals at release, and the higher their mean temperature during the whole cycle, the less the demand for heat from the entering steam.

Were it practicable to introduce superheat sufficiently high to maintain the steam superheated during expansion, in the high pressure cylinder of compound engines, and consequently dry even superheated at release, further and important economies might ensue; practical objections, however, such as unequal expansion of and debilitating action upon the metals and working parts, defective lubrication, abrased valves, scored and distorted cylinders, burnt packings, etc., render such a course difficult of operation, costly and dangerous. On the other hand, dry steam can, with economy, be obtained at release by jacketing the cylinders with superheated steam. The comparative economies derived from jacketed cylinders, as against non-jacketed, are apparently greater when superheated steam is used for cylinder and jacket than when saturated steam is similarly employed, especially where the stroke is long and the speed slow.

It will be seen from the foregoing remarks that practically the whole of the increase in the efficiency of the steam and of the engine effected by superheating is derived from its influence to preserve and protect the steam after it has left the boilers, from loss of expansive properties by condensation, and that the further along the cycle of work the steam can be carried "dry" and saturated, the greater will be the measure of the benefit conferred.

It would also appear that superheat does not directly increase the inherent power-developing properties of the saturated steam to an extent commesurate with the heat expended on its production, and that, if absolutely dry steam could be generated, and condensations through radiations of heat in the steam pipes, chest and cylinders, could possibly be overcome by any other effective and less costly means, the expenditure of heat might be more usefully and economically applied to raising the pressure of the saturated steam and thus multiplying the range of expansions in the cylinders.

Some engineers have inferred, basing their calculations on imperfect data, that the addition of superheat to high-pressed steam, say at 300 lb. on the square inch and upwards, will result in comparatively little improvement in the efficiency of the steam. It has also been advanced that superheat can advantageously be substituted to equalize the differences in efficiency between high and low pressures.

Recent experiments would seem to point to a judicious combination of high pressures with high superheat, and that whatever advantages in engine economy and efficiency have been realized in the past from raising the pressure of steam, when used saturated, reappear in greater force when the high-pressed steam is superheated. Indeed, the necessity of maintaining the steam perfectly dry, at least up to the cut-off, if the greater expansive power due to the higher compression is to be usefully exerted, would tend to establish that the higher the pressure the greater the need for superheat; for, as the temperature rises, the percentage of latent heat of evaporation diminishes, while the rate of radiation increases and the more rapid is the condensation. High-pressed steam is not necessarily "dry" steam, and we see no reason why the weight percentage of unevaporated moisture should be less in steam at 300 lb. pressure than at 100 lb. pressure generated under similar conditions.

In establishing the balance of the respective merits of high and low pressures against the economies, solely of steam, and the advantages of greater power from less weight and space occupied, resulting from working at these high pressures, account should be taken of the increased initial cost of the entire steam plant-boilers, pipes, cylinders, fittings, etc.—as also the increased annual expenditure for repairs and maintenance. In marine-practice, where space and weight are of utmost importance, these considerations may be somewhat neglected; for stationary plants, however, such as mill-engines and the like, they prove sufficiently strong to cause engineers to seek all-around economy at moderate pressures and to equalize the higher steam consumption by lower capital outlay and a minimum repair and maintenance tax.—*Engineering Times*, London, England.

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Horseless Fire-Engines

It may not be many years before horses will be entirely done away with for drawing fire engines. A complete outfit of motor fire apparatus has lately been installed in Hanover, in Germany, and operated with great success.

The construction of these machines is simple. Two separate steam motors are employed on each, both being fed from one boiler placed at the rear of the machine and heated with liquid fuel. Only one of the motors is used for propelling the machine, while the other is attached permanently to the pumps. When the scene of a fire is reached, the propelling motor is uncoupled from the driving gear and at once connected with the pumps, whose power is thereby greatly increased. In other words, all that it is necessary to do in order to transform the vehicle into a serviceable fire engine is to close one valve and open another.

The particulars wherein this motor engine is said to excel are these: It can cover the ground quicker than the ordinary machine, being able to run at the rate of a mile in two minutes; it can go further, 30 miles being its limit with a single supply of fuel; it can be prepared for action more speedily, only a few seconds being required to set it in motion; and the cost of maintaining it is, comparatively, very slight. The engine in question is of 30 horse-power, the source of which is petroleum. The use of petroleum is, in itself, regarded as a highly commendable feature, inasmuch as no sparks arise from its combustion, as in the case of coal.

The machine is steered by means of a hand wheel, which actuates a vertical shaft attached to the fore axle, the process being facilitated by a small sprocket wheel and roller chain. The steering wheel and the levers controlling the brake and the reversing mechanism are all within easy reach of the driver, near whom there is another wheel which operates an auxiliary brake, to be used in case of an emergency. Special attention has been paid to the braking equipment, and it is possible to bring the engine to a stop when going at full speed within a distance of a few yards. The engine will carry the usual complement of firemen, together with a long stretch of hose. Its approximate weight when fully equipped is a little less than three tons. The pumps are capable of delivering 300 gallons of water per minute and of forcing it to a height of nearly 150 feet.

The Plant of The South Jersey Plate Ice Co.

There are many artificial ice-manufacturing plants in daily operation throughout the country, and while the different systems in use are fundamentally the same, yet the constant endeavor to make a maximum amount of ice with a minimum amount of expense, is continually resulting in improvements in the various details of the plants until, at the present time, it is almost impossible for one to find two plants alike, even when built by the same manufacturer. Conditions which govern the installation of an ice-manufacturing plant are so different that this is inevitable. Hence, in building a plant for this purpose, it is well to study the surrounding conditions with an eye to the economic. It is also well to have the engineer, who is to have the practical charge of the plant, go over the details.

The accompanying illustrations are descriptive of a system operated under the most ideal conditions, in so far as natural surroundings are concerned, but, in confirmation of the theory that the factory must be made to conform to these conditions, instead of conforming the conditions to any set style of design, many changes have been found necessary to complete the plant, and changes which could have been foreseen.

However, as it stands to-day, it is an ideal ice-producing factory—a fifty-ton plant producing daily sixty-four tons of beautiful clear plate ice, hence a description in detail will probably be of interest.

First, we find lots of room—a very necessary feature.

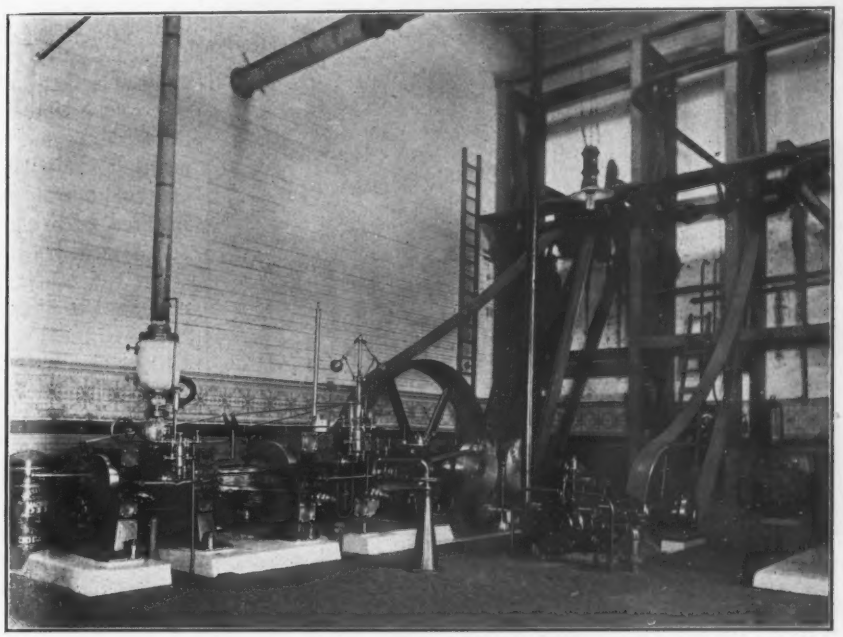
The machinery was installed by the York Manufacturing Company; the ammonia compressor, which is shown in the cut on front cover, is driven by an engine of the Corliss Compound type, 17 by 34 by 32; steam pressure, 130 pounds. From the compressor we go to the brine tanks; here we find a system replete with economic conditions in combination with the freezing of the plates of ice—this is entirely a plate system. The brine is first used to freeze with, by circulating it by means of a set of Duplex pumps.

During the entire freezing process, in order that conditions may follow nature as near as possible, the water, of which the ice is made, is kept in a perfect state of agitation by a continued injection of compressed air, in this way insuring ice of the purest type obtainable.

After the plate, about four and a-half tons in weight is frozen, instead of using hot water from the boilers to loosen the plate in order to draw it, warm brine is used. This is circulated through the coils, in place of the cold brine, until the plate becomes loosened, thus utilizing the cold, which would otherwise be lost, to reduce the temperature of the hot brine.

The plates of ice are handled entirely by means of motor-driven machinery. First, the lift carries the plate to an inclined table; here it is sawed into blocks, and from thence it is carried, by means of an inclined chute, into the storage rooms, which have a holding capacity of 6,000 tons.

Leaving the freezing-room, we follow the ammonia back to the condensers, and here we find the secret of the increased output over the normal. The condensers are of the type manufactured by Williamson & Campbell, and are known as the double-pipe system—that is, the ammonia pipes are jacketed by an outer pipe which is continually flushed with cool water. This style is superior where plenty of water can be had and a sufficient amount of condenser surface is supplied. In this case, the condenser contains ten coils, twelve pipes high, sixteen and a-half feet long, giving 1980 lineal feet of cooling surface. The water used for all purposes about the plant is taken from two artesian wells. It is as near perfect as one could ask, never reaching a higher temperature, as it comes from the wells, than 54 degrees. Thus one can readily see the primary cause of the high production, although



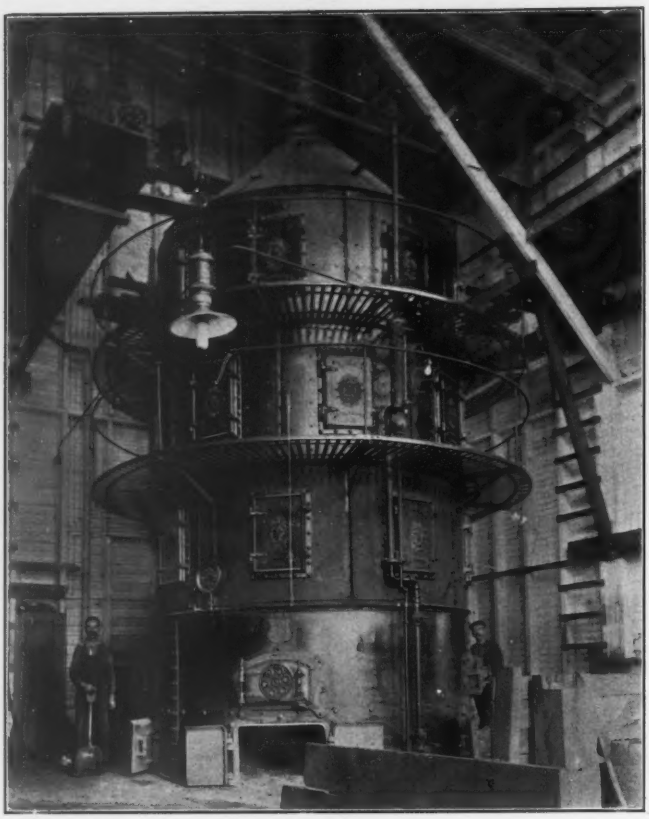
TANDEM COMPOUND CORLISS ENGINE, DRIVING 30 KW. DYNAMO AND AIR COMPRESSOR

the surplus over the 50 tons was not reached without considerable changing and adding to in places, of special devices. The Chief Engineer, Theodore M. Herr, in order to increase the efficiency of the condensing plant installed, in addition to the inside flushing system, introduced a device for outside flushing the whole ammonia condensing system, which has been the means of assisting largely in increasing the output.

The water from the wells is of such quality that it can be used for freezing without filtering, or treatment of any kind, hence it is pumped directly into the freezing tanks from the well. For use in the boiler it is not so good, containing a considerable amount of iron, magnesia and chloride of sodium, therefore extraordinary efforts have been made to preserve the boiler against its effects.

The boiler feed-water is first admitted to a Berryman heater, then to a smaller heater using the pump exhausts; from there the water is forced into a Dougherty Live Steam Separator and Purifier, manufactured by James Dougherty, Chester, Pa. This Purifier is constructed so that there is an injection of live steam into the flow of feed-water; the water, after attaining a degree of heat sufficient to expel the impurities, then passes upward through a sand-filter, contained in the Purifier,

after which it is conveyed to the boiler by gravity. The boiler, which is shown in the illustrations, is of the T. F. Morrin Climax type of 350 horse-power—a single boiler being sufficient to maintain steam-pressure enough to operate the entire plant. This boiler, as will be seen, is of the vertical type, the central part is a cylinder, 3½ feet in diameter, into



350 H. P. MORRIN CLIMAX WATER-TUBE BOILER

which the tubes are set from top to bottom, the whole being encircled by an outside shell or flue, thus passing the hot gasses through the nest of tubes, the upper rows acting as a final feed-water heater, the water flowing from the Purifier into the tubes, from thence into the base of the boiler.

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Safety valves often stick and will do so sometimes even though tried every day, if they are simply lifted and dropped to the old seat again. If a boiler should be found with an excessive pressure on it, it would be one of the very worst possible things to do to start the safety valve from its seat unless extra weight was added, for should it once start, it would so suddenly relieve the boiler of such a volume of steam as would cause a rush of water to the opening, and, by the blow, just the same as in water running, rupture the boiler.

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CAUSES FOR SMALL WAGES.—Every employee pays for superintendence and inspection. Some pay more and some less. That is to say, a-dollar-a-day man would receive two dollars a day were it not for the fact that some one has to think for him, look after him, and supply the will that holds him to his task. The result is that he contributes towards the support of those who superintend him. Make no mistake about this; incompetence and disinclination require supervision, and they pay for it, and no one else does.

The Great Anthracite Coal Strike

One might almost believe that the weather, which has been unusually cool during the summer just coming to a close, was in some manner attributable to the gigantic war between capital and labor, which for sixteen long weeks has waged with marked determination between the employing operators and the mine workers of the great anthracite coal fields of Pennsylvania, so far-reaching has been its destructive effects. But still we stand aghast, eagerly and anxiously awaiting the final outcome, which, but for the knowledge that all things have their limitations, would seem as far removed as when the strike began.

Every industry in the East has felt its effects, and every householder dreads the approach of winter, and shudders when he thinks of the probable cost of his fuel. Indeed, unless the dispute is speedily terminated, the cost will not be a matter for consideration, for it will be impossible to get anthracite coal at any price. Every mine in the region is closed tight, and the strikers, numbering upwards of two hundred thousand men seem, if possible, to be more determined to win than when the strike began. They are fairly well provided with funds and have implicit faith in their leaders, who claim that they can hold out for months yet. Ever leader in the region seems inspired with a quiet determination that can only be the result of supreme confidence of ultimate victory.

On the other side are the millionaire operators who have combined to fight the Union, and who, up to the present, have declared that "there was nothing to arbitrate." At least, this is the statement of President Baer, of the Reading Railroad, who appears to be the spokesman of the operators' "Union."

It must take a heartless egotist to say to two hundred thousand men, who have a grievance in support of which they have placed themselves and their families in danger of starvation, that "there is nothing to arbitrate."

However, there are indications that since the strikers' strength seems to increase rather than diminish, that the operators may yet find it advisable to either arbitrate, or grant the desired concessions. How much better to have done so in the beginning, as the men requested. For, undoubtedly, they must ere this began to realize that when gold looses its power and men, with a common cause, stand shoulder to shoulder, as men should, that the many are mightier than the few; also, that the loss of many millions is a mite for which they can afford to swallow a little self-assumed dignity. For, even if the strike were settled at once, the cost is staggering.

The estimated losses at the end of the 14th week of the strike follows:

Loss to operators in price of coal (normal)	$33,050,000
Loss to employees, other than strikers	4,200,000
Loss to strikers, in wages	16,600,000
Loss to business men in the region	11,200,000
Loss to business men outside the region	6,200,000
Cost of maintaining coal and iron police	840,000
Cost of maintaining non-union workers	340,000
Damage to mines and machinery	6,500,000
Cost of maintaining troops in field	150,000
Total	$79,080,000

Nor is this all. While the wily operator was busy chastizing his men, and, in fact the whole coal consuming public, for daring to even approach their throne, a subtle enemy was gradually stealing in upon them, until to-day, if the anthra-

cite mines were to open up, they would find that instead of one grand rush to buy their product, that many engineers of manufacturing plants, who were formerly partial to anthracite, but who have been driven to bituminous coal, will continue with their new love. Not only will they do this because of proven economy, but because many of the firemen actually prefer to handle the soft coal.

Thus, if the operator should win the strike, which appears highly improbable, he has already lost a market worth many millions, which it will take years to regain.

The operators claim that the men will share in this loss through loss of steady employment, but the claim is not well founded, for thousands of the men have already gone to the soft coal fields from which they will never return, and other thousands have left the region to engage in other pursuits, and will never go back to the mines. Indeed, if every mine in the region would open now, it is almost a certainty that there are not enough men there to work them to their capacity.

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Old Friends in New Clothes

Part VII.

By A. Edward Rhodes.

WATER HAMMER AND FEED WATER

What is known as water-hammer action is familiar to every one who has to do with the use of water for heating purposes. The astonishing noise, the violent shocks, the excessive vibrations which are set up if a little steam is formed and then condensed in the pipes, are much better known than is the remedy therefore.

An instance of water-hammer action that has caused considerable trouble is supplied when boilers are "blown down," or when scumming takes place, so that steam shall pass into the sea outside. A large ship will shake from stem to stern at such times, cabin doors will sometimes open and shut, crockery will go adrift, and the noise made by the water fighting its way into the vacuum, and the steam trying to get out, and being condensed in the act, echoes through the ship. Scumming is known to be positively dangerous from the way in which it shakes the boilers, bringing the scale off the tubes in flakes on to the furnace crowns, where it adheres in such quantity that they subsequently become red hot and come down.

Some years ago an English engineer who evidently had given much thought to the cause and effect of water-hammer, made a curious and interesting experiment. He took a large funnel, fitted with a stop-cock, and screwed the pipe into the top of a boiler containing steam of about 40 pounds pressure. He then filled the funnel with cold water and opened the stop-cock. It would naturally have been predicted that the steam would have blown all the water out of the funnel. It did nothing of the kind. On the contrary, the water rushed into the boiler.

As a result of this and a number of other experiments, a boiler feeder was designed and patented, and worked with tolerable success. It was found, however, that it was not certain in its action, and the injector coming into high favor at the time, the inventor spent no more money on his ingenious idea. The inrush of the water was due to the fact that the steam condensed in the long pipe of the funnel and the water-hammer action then forced the water into the boiler. Practically just below the cold water there was always a vacuum into which the water was driven by its own weight and the pressure of the air. I would like some of our practical men to investigate this method of feeding water into boilers and give us the benefit of their ideas through the Letters from Engineers' Column.

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From the above the transition to the subject of *Fire-Boxes and Fuel* is easy, and owing to many employers of engineers purchasing a coal that is not adapted to the kind of fire box used, always I believe because they do not know that each boiler and its accessories were designed to meet certain given requirements, and that various sizes and kinds of coal needs various kinds of fire-boxes, grate-bars, and a different kind of firing for each individual case.

In considering the question of the most suitable form and size (notice I put form before size) of fire-boxes for burning an inferior fuel, the kind most engineers must use, care should be taken to distinguish between small coal and dirty coal. It is true that both terms are often synonomous, but it is not always true that all small coal is full of dirt, and few of us would care to assert that all dirty coal is small. In either case, the useful work done by the coal will depend upon the amount of combustible matter it contains, and the heating surface and the cubic contents of the fire-box should be proportioned to this amount of combustible matter rather than to the gross weight of the coal. The fire-box and heating surface have mainly to deal with the products of combustion, and to develop and extract all the heat possible from the combustible matter.

The grate, on the other hand, has to deal with the gross mass of coal. If the coal is nearly pure, or, in other words, contains little ash, it will continue burning for a long while and leave the grate unincumbered; but if the coal is dirty, the resultant ash and clinker will accumulate rapidly, either filling the ashpan or blocking the air way through the grate-bars. The combination will, therefore, be imperfect, and it is obvious that any excess of heating surface will not mend matters. Either nearly the whole supply of air necessary for combustion must be admitted above the fire, or the grate must be cleaned. The latter method must ultimately be resorted to in all cases, for it is only a question of time when the fire-box would be filled with ashes and clinker. It is, therefore, not surprising that shaking grates and drop plates are in very general use, while the admission of air above the burning fuel is the exception rather than the rule.

It is obvious that the need of a shaking grate and the admission of air above the fuel apply to a dirty coal, whether it be large or small. If a given coal is broken up the amount of dirt remains practically unaffected unless it is picked out by hand, and as dirt cannot be burnt, it must be got rid of, whether the coal be originally large or small.

The size of coal does, however, influence considerably the size of the grate mainly on mechanical rather than on chemical grounds. The finer particles of coal necessitating a closer spacing of the grate bars and consequently a smaller air admission in proportion to the gross area of the grate. But as small coal burns best in a thin fire, this discrimination of air passage way is especially prejudicial. The draft is not only sharper, but it encounters less resistance, owing first to the smaller size of the individual particles of coal, and secondly,

owing to the thin layer of coal through which the air has to pass. The greater velocity of the entering air tends to lift the fire, making sparks, and as the fire is thin, it is soon burnt into holes.

The mechanical effect of the upward rush of air on the small coal may be diminished either by decreasing the volume of air or by distributing it over a greater area. In other words, a larger proportion of the total supply of air must be admitted above the grate bars or the grate area can be extended.

A little consideration of these self evident facts shows the reason why the use of an excessive amount of heating surface has not given satisfactory results from an inferior coal. The amount of heating surface depends rather upon the amount of steam to be evaporated in a given time than upon the quality of the coal, but the nature and size of the grate should depend largely upon the size of the coal and the amount of the ash and clinker.

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A Disastrous "Pulp-Boiler" Explosion

The most terrible boiler explosion that ever occured in Wilmington, Del., happened on August the 20th, in that city, at Delaware Pulp Mills, owned by the Jessup & Moore Co., the result being most disastrous, seventeen lives being lost and a number of persons injured, not to speak of a considerable loss of property.

Strictly speaking from an engineering standpoint, the accident would not come under the head of steam-boiler explosions; the accident arising from the bursting of two large steel digesters used for cooking the wood pulp—only another instance demonstrating the advisability of having none but competent licensed men in charge of steam-boilers of any kind requiring pressure.

The Delaware Pulp Mills are located on the Marsh road, or Justison Street, extended, just near the city line, and have been in operation more than twenty-five years. The boilers or digesters that exploded were of a nest of ten erected in the boiling and wash-building, as it was termed. This building was about 100 feet in length, and about 75 feet wide, and built of brick. It was high, in order to accommodate the digesters, although of but one story, with a cellar. Surrounding this building was the engine-room, in which the power for the factory was generated, and the chipping-room, in which cedar logs were first cut to chips before being loaded into the digesters. On the south side of the wash and boiler-building was the alkali-building, and other buildings of the plant. All of these structures are of stone or brick.

The ten digesters in the boiler and wash-building stood in one row. The digesters proper were about six feet in diameter, and about 15 feet in length, and each set upright over a fire-box, in which the heat for boiling was generated. The boilers were constructed of 5/8" wrought-iron, lap welded. On the top of each boiler was a removable cap, to permit of the loading of the chips of wood into the boilers when ready for the process of boiling to reduce the wood to pulp. Each digester had a capacity for one and one-half cords of wood, and, with the chips, a quantity of lime-water and soda was placed in each, they being the ingredients necessary for the reduction of the wood to pulp.

HAVOC CAUSED BY THE GREAT DIGESTER EXPLOSION AT THE DELAWARE PULP MILLS, SHOWING LARGE ALKALI MIXING PANS IN FOREGROUND. SOME OF THE DIGESTERS STILL STANDING SHOW INDISTINCTLY UNDER STEAM CRANE

After the digesters were charged with wood, lime and soda, the top caps were adjusted tightly, and then they were ready for the boiling process, which lasted six hours. Each digester or boiler was fitted with a safety-valve, for the escape of accumulating steam, if it would be generated in too great quantities within the boilers.

About eighteen workmen were employed in the departments containing the digesters; several of these were firemen, others assisted in the process of washing, after the boiling is com-

pleted, and others helped to prepare and chip wood to be fed into the digesters. Of these seventeen were killed, for they were caught like rats in a trap.

The digesters which exploded were twisted and torn apart. The portions that remained in the building were in an unrecognizable shape, while a large section, weighing several tons, was blown into the air and fell probably 200 yards away burying itself deep in the ground.

The buildings were chiefly of brick and nearly all of the walls fell in instead of out, while the roofs, which had been blown up, fell in sections, leaving a great heap of debris 30 feet high. The room containing the digesters was little more than a pile of bricks and timbers, with fragments of twisted iron protruding, after the accident. A battery of twelve boilers were displaced by the explosion and the other digesters felt the effects, some being jarred to such an extent that they looked as if they were ready to fall as soon as the debris surrounding them should be removed. This condition made the rescue work more hazardous than it would otherwise have been.

The direct cause of the explosion will likely never be known —all who were near the fatal spot being killed. A number of theories have been advanced, one report saying that the exploded digesters had defective valves; it is more likely, however, from the conditions apparent, that the pulp became baked fast to the base of the shell, resulting in overheating the sheets, thus weakening them. That this is likely, is evidenced by the nature of the explosion, the ruptured digester being driven straight up in the air for about 500 feet with a complete wrecking of the building on all sides alike, showing that the rupture was apparently directly in the centre beneath the boiler.

The scenes of horror usually attached to such accidents were heightened by the ruins taking fire, thus precluding all chance of escape for those pinioned beneath the debris. The fire department succeeded, however, in subduing the flames before the bodies became burned.

The pressure usually carried on the digesters was 110 pounds and the safety valves were set to blow off at this point. It is said, however, that the digesters have not been inspected this year, as has formerly been the custom of the company, and that they were not in good condition.

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Reading Vacuum Gauges

By R. T. Strohm

The earth is enveloped in an atmosphere several miles in depth, and, this air, on account of its weight, presses upon the earth with an intensity of 14.7 pounds to every square inch. This, then, accounts for the common expression that 14.7 pounds represents atmospheric pressure. If there were no atmosphere of any sort, there would be no pressure upon the earth's surface, and we should have zero pressure to reckon from.

It is comparatively easy to prove that the atmosphere exerts a pressure of 14.7 pounds to the square inch. Take a glass tube of uniform internal diameter, about three feet long, with one end closed. Fill this tube with mercury, and, then, holding the thumb over the open end to prevent the mercury from escaping, invert the tube and place the lower end in a bowl of mercury. Then remove the thumb from the tube, still keeping the open end submerged. It will be noticed that the mercury will fall in the tube and that when it finally comes to rest, there will be a column about 30 inches in height, with an empty space above the column.

This instrument is known as the mercurial barometer, and may be used to register all changes in atmospheric pressure. For the atmosphere does change its pressure. On the top of a high mountain there is a shorter column of air pressing upon the earth, hence the barometer will stand at a less height than 30 inches. On a very cloudy oppressive day, before a rain, the barometer will register more than 30 inches. For this reason the instrument is invaluable in giving indications of weather variations.

Mercury weighs .491 pounds per cubic inch. So that a column of mercury 2.03 inches in height represents a pressure of one pound. Then a column, 30 inches high, represents a pressure of 30÷2.03=14.7 pounds, which is atmospheric pressure.

To the engineer, however, the principle of the mercurial barometer is particularly valuable in determining condenser pressures. Suppose that we were to place the barometer, tube and bowl together, under the receiver of an air pump, and exhaust some of the air, so that the mercury column measured only 20 inches in height. By this operation we have taken away a portion of the pressure due to the atmosphere, and so it could no longer support a column of mercury 30 inches in height. Instead, the column decreased until equilibrium was again restored. That is, until the column pressed downward with the same pressure per square inch that the atmosphere in the receiver exerted on each square inch of surface of the mercury in the bowl.

When the barometer is in the open air, it stands at 30 inches and represents a pressure of 14.7 pounds. That is, each inch represents .49 pounds pressure. Then 20 inches must represent 20x.49=9.8 pounds. Consequently we have reduced the air pressure in the receiver by an amount equal to 14.7–9.8= 4.9 pounds. If we could keep on exhausting the air from the receiver until we had obtained a perfect vacuum, then the mercury in the tube would stand at the same level as the surface of that in the bowl.

Now, in actual practice, the mercurial barometer is too expensive and too bulky and unwieldy to use for the purpose of showing the state of vacuum obtained in a condenser, and in its stead we use the vacuum gauge.

The vacuum gauge differs from the ordinary pressure gauge in that it is graduated to read in inches instead of pounds, and to register pressures below atmospheric instead of above it. The internal mechanism and the principle are the same as in the common steam gauge.

The dial is graduated in divisions ranging from zero to thirty. When the pointer stands at zero, there is atmospheric pressure within the tube of the gauge. Let the gauge be attached to a condenser, and, suppose the pointer to move to 25 inches on the dial. We then say that we have 25 inches of vacuum in the condenser. If we could obtain a gauge reading of 30, the cendenser vacuum would be perfect. However, we have removed pressure corresponding to a column of mercury 25 inches high, so that the pressure which remains in the condenser is only that corresponding to 30–25=5 inches of mercury, or 5x.49=2.45 pounds. In a similar manner, the pressure corresponding to any reading of the vacuum gauge may be calculated. To make such work unnecessary, however, and to put such results in a concise form, the accompanying table is compiled, from which the absolute pressure can be quickly ascertained, knowing the reading of the vacuum gauge in inches.

Vacuum Gauge. Inches.	Absolute Pressure. Pounds.	Vacuum Gauge. Inches.	Absolute Pressure. Pounds.
0	14.70	16	6.86
1	14.21	17	6.37
2	13.72	18	5.88
3	13.23	19	5.39
4	12.74	20	4.90
5	12.25	21	4.41
6	11.76	22	3.92
7	11.27	23	3.43
8	10.78	24	2.94
9	10.29	25	2.45
10	9.80	26	1.96
11	9.31	27	1.47
12	8.82	28	.98
13	8 33	29	.49
14	7.84	30	.0
15	7.35		

The Practical Engineer.

PUBLISHED ON THE FIRST OF EACH MONTH

By L. L. RICE, Proprietor, - - - - 1213-15 Filbert Street, Philadelphia, Pa.

THE PRACTICAL ENGINEER WAS ENDORSED BY THE SUPREME COUNCIL OF THE UNITED STATES OF THE

American Order of Steam Engineers,

ON MAY, 13, 1897, AS ITS OFFICIAL ORGAN.

PUBLICATION COMMITTEE:

FRANKLIN R. MOORE, *Chairman.* J. C. MCDOWELL, *Secretary,*
GEO. W. RICHARDSON, *Treasurer.*
FRED. W. MOORE. LOUIS WOODINGTON.

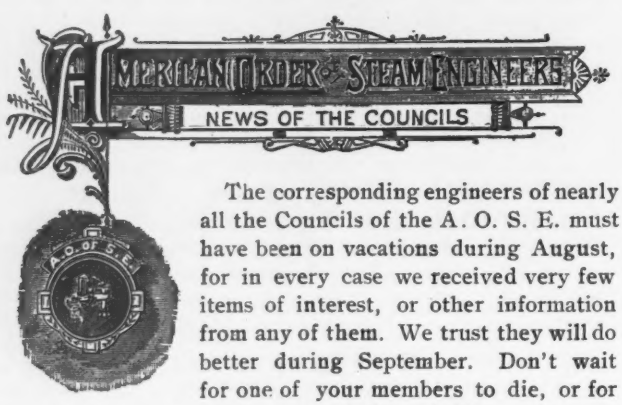
Address all Communications
and make all Checks, Money Orders and Drafts Payable to

THE PRACTICAL ENGINEER,
1213-15 Filbert Street - - Philadelphia, Pa.

SUBSCRIPTION RATES IN THE UNITED STATES, CANADA AND MEXICO FIFTY CENTS THE YEAR IN ADVANCE.

FOREIGN SUBSCRIPTIONS TO COUNTRIES WITHIN THE POSTAL UNION, POSTAGE PREPAID, ONE DOLLAR THE YEAR IN ADVANCE.

Entered at Philadelphia Post-office as Second-class Matter.



The corresponding engineers of nearly all the Councils of the A. O. S. E. must have been on vacations during August, for in every case we received very few items of interest, or other information from any of them. We trust they will do better during September. Don't wait for one of your members to die, or for a boiler to explode and blow some one through a brick-wall without hurting him; there are lots of little things that your members and their friends would like to have published, and it is these "little" things that we want you to write us about.

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York Council

The following new officers of York Council, No. 16, York, Pa., were installed by Supreme Chief Engineer Clifford P. Williams, on Saturday evening, July 19th:

Chief Engineer, A. L. Bair; Assistant Engineer, J. Wasbers; Senior Master Mechanic, C. L. Brett; Junior Master Mechanic, Elmer Erhart; Chaplain, L. Christ; Recording and Corresponding Engineer, Walter H. Long, 23 East Philadelphia Street; Financial Engineer, H. W. Callahan; Inside Sentinel, Jno. Graybill; Outside Sentinel, Geo. Wells; Delegate to Grand Council, W. H. Long; Alternate, H. W. Callahan.

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The installation ceremonies were followed by an open meeting and banquet, attended by a large number of the local friends of members and visiting engineers. The principal address of the evening was delivered by the Supreme Chief.

We have just recently learned, with much regret, of the death of Mr. Chas. H. Cummings, of Winthrop, Cal. Mr. Cummings was an engineer of more than ordinary ability, and was well-known in his own section, where he has been an earnest advocate of the The PRACTICAL ENGINEER from its beginning. He was shot down on June the 5th by a drunken man, without cause or provocation, and died within a few hours.

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The "Diamond" State Boys are Royal Hosts

Delaware Council, No. 1, of Wilmington, held a special open meeting on Sunday, August the 24th, for the reception of a party of visiting brothers from Baltimore, and the result was an exceptionally pleasant day for all present.

There were nineteen in the party from Baltimore and when they reached Wilmington, at 10 A. M., they were met at the depot by a special committee from Delaware Council, who escorted them in busses to a large hall at 206 East 4th St., where after a round of pleasant greetings, all sat down to a most excellent lunch.

Included at the board were Supreme Chief Clifford P. Williams and Past Supreme Chief Engineer Franklin R. Moore, of Philadelphia.

Brother A. E. Deakyne made an address of welcome which was responded to by Supreme First Assistant Noah A. Pierson, of Baltimore. After lunch, the visitors were conducted to the water-works pumping station, the Wilmington City Electric Light Station, and other important power plants, after which the entire party boarded special trolley cars for Brandywine Springs Park, which is about six miles from the city. Here the balance of the afternoon was spent at games and other amusements.

McGee, of Baltimore, was, as usual, the comedian of the party, and his pranks and witticisms afforded endless amusement, but he "took water" when challenged to play pinocle with "Father Jones'" pig.

Early in the evening the visitors returned to the city and took the train for home, all voting the Delaware boys royal hosts.

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Work for You

[THIRD LETTER]

PHILADELPHIA, August 15th, 1902.

To the Individual Member of the American Order of Steam Engineers:

DEAR SIR AND BROTHER:—When this, the third of the open letters, shall have reached you, the summer months will have been a thing of the past, so far as the calendar goes, and the season of high temperatures and excessive humidity will, in all probability, be no longer available as an excuse for inactivity along the line of promoting the growth of our Order by increasing its membership.

I fully realize that the summer season is not at all conducive to ordinary, let alone extraordinary exertion, in any field of voluntary labor, and I am conscious of the fact that the conditions under which the largest proportion of us, as engineers, work during such season in pursuit of a living are

so exacting upon our physical resources as to render an expectation of energetic work for the upbuilding of our Order almost beyond the pale of reason.

Nevertheless, I am convinced that this is the proper time to look over the field and carefully consider what can be done to increase the membership of our Order during the cooler months that are now at hand. I would, therefore, suggest that you direct the energy of your thinking mechanism toward solving the problem as to what you, as an individual member of the American Order of Steam Engineers, can do to secure a large addition to its membership. I would also suggest that you go further than this; that in addition to planning the best means of obtaining this necessary result, you also make preparation to put such thoughts into execution so that the organization may be benefited by the fruition of your labor, both as a thinker and a worker.

SOME MEMBERS OF C. P. WILLIAMS COUNCIL, WITH THEIR WIVES AND CHILDREN, SISTERS AND SWEETHEARTS, ENJOYING AN OUTING IN THE WOODS ALONG THE SHORE OF LAKE MICHIGAN, ABOUT TWO MILES FROM MILWAUKEE

As previously pointed out to you, it is not only advisable for you to determine to do a certain thing, or say that you will accomplish a certain result, but it is also absolutely necessary that you endeavor to obtain the object of such resolution. This proposition is here repeated in order to impress upon you the fact that a determination to do amounts to nothing if it is not supplemented by energetic endeavor, and, to make it still more impressive, I would remind you of that old, and time-worn adage concerning men of words and not of deeds, etc. I ask your indulgence in thus inflicting upon you such antiquated phraseology; however, I do hope that you as an individual member of our Order, will never reach a state of inactivity to warrant such comparisons, but that your deeds, in conjunction with those of your brother-members, will be productive of such good results as to merit commendation among those occupying the pinnacle of success. Wake up! There is no question in my mind but that you desire our Order to grow and prosper; that you earnestly wish to see its membership increased to a greater degree than it has heretofore attained. But how do you hope to bring about such a condition if you, as an individual member, do nothing to produce such results? You certainly know that you must sow before you reap; that you must induce your fellow-engineers to become members of the Order before you can expect its membership to increase.

Hence it behooves you to get to work and implant the seed of the knowledge you possess, of the good of our Order, deep in the minds of all your competent fellow-craftsmen that you meet, so that the organization may reap the harvest of your good works, thus adding to its unity and strength, making it a powerful medium, to promote the success of its members and to place it upon a pedestal which will insure the admiration and respect of all men; finally resulting in the means of placing the American Order of Steam Engineers on a footing in the industrial world commensurate with the nature and responsibility of the steam engineer's duties.

Your duty to the organization, and to yourself, requires you to assist in every effort that is put forth to add to the membership of the subordinate council of which you are a member. Is it your place to encourage others to take an interest in the Order by showing your disinclination to accept the benefits of the Order, and, at the same time, do nothing to increase those benefits? Now, think it over. Is it right to expect the organization to benefit you when you discourage, by your lethargy and inactivity, those brothers who show that they consider the welfare of the Order a matter of individual responsibility?

As an individual member you will be benefited by interesting yourself in promoting the progress and prosperity of our Order, by helping to increase its membership. The individual as a unit always partakes of either the strength or weakness of the whole, consequently any effort which produces strength in the organization must benefit each individual member thereof. I would, therefore, appeal to you to do your utmost to add to the numerical strength of the American Order of Steam Engineers as, by so doing, you not only labor for the benefit of your brother-engineers, but you promote your personal interests as well.

In increasing the membership of our Order there is profitable work for you.

Fraternally yours,

CLIFFORD P. WILLIAMS,
Supreme Chief Engineer A. O. S. E.

LETTERS FROM ENGINEERS

In order to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories and general engine room experiences are especially solicited.

Grease Versus Oil

Editor PRACTICAL ENGINEER:

Only a few years ago one could seldom find an engineer who was not a little scary about using grease as a lubricant upon troublesome bearings. To-day this idea is somewhat reversed, yet there are hundreds of engineers who would hesitate when it came to using grease upon the crank pin of a large engine—say of a thousand horse-power or larger. Yet the writer has seen, in different parts of Europe, a large number of engines of even larger horse-power than above mentioned successfully using grease in this way, they being supplied with centrifugal oilers similar to those in use in this country for oiling such bearings. These oilers, in cases where grease was used, were supplied with the lubricant under pressure from a small pump worked from some convenient reciprocating part of the engine.

The writer has seen a large number of such arrangements, not one failing to give satisfactory results.

Until about three years ago I was fearful of using grease upon any bearing of consequence whatever. At the time I had charge of a cross compound engine, which gave me much trouble with the heating of the eccentrics. As there were four eccentrics upon the engine, it meant the daily expenditure of a considerable amount of oil to keep them anywhere near cool. Oil catching pans were provided, yet a great deal of the oil was wasted, and, with all this, I still had the trouble mentioned of heated bearings.

However, one day when we were having some of the same old trouble, an engineer of more than the average experience came in, and, upon being asked his advice upon the matter, he suggested the use of grease. He said that we would find that we would have no further trouble if we did so. After considering the matter for awhile and the trouble still continuing, I determined to try a grease cup upon one of the eccentrics. In making the application I took care to leave the old oil holes so that should the bearings become dangerously hot during the grease experiment, I would have no trouble in flooding the bearings with oil, as I felt almost sure they would. You can judge my surprise to see that the bearing only became slightly warm. After running for two days and finding no signs of trouble, we then equipped the entire set of eccentrics with the grease cups, and I am pleased to say that we have not since experienced the slightest trouble from the eccentric bearings heating.

As to using grease upon the main bearings of the engine, I have never yet had the nerve to try such an experiment; and, with the present design of many of our engines, I would not think it advisable to use grease as the sole lubricant. But it seems to me that it would not be a very difficult matter to so design the bearings that they might be used either for oil or grease.

One might ask, is there other advantages in the use of grease than that of cool bearings. For myself I would say that was sufficient even though the grease were more costly than oil. Yet, if we have less heat in our bearings, we have a corresponding reduction in friction load of the engine.

S. L. H.

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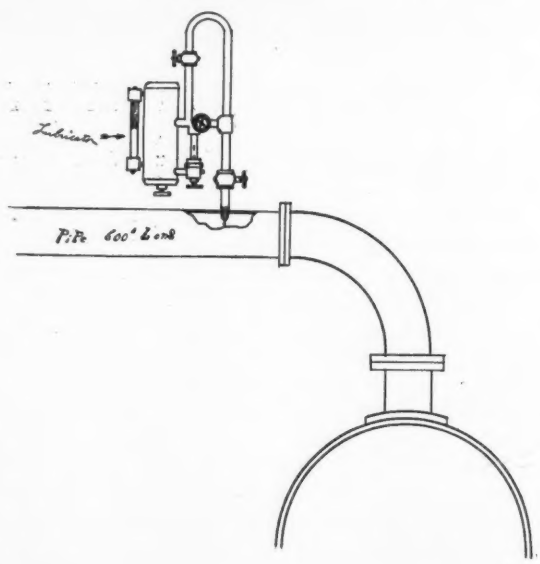
A Unique Experiment

STOPPING LEAKS IN STEAM MAINS

Editor PRACTICAL ENGINEER:

There is probably no other portion of steam plants causing so much trouble and petty annoyance to those in charge than leaks in the steam conducting mains, or pipes; especially is this true of places where the pipe is of large diameter and a long run. A leak first of all always is an eye-sore to the careful engineer, the drip from it usually forming an ugly yellow streak about it. Nor is the matter of sightiness the greatest feature. Leaks are always a source of continuous expense through loss of steam. Many times these leaks occur in places where it may be easy to reach them for caulking purposes, but more often the trouble will occur in places where access is, to all practical purposes, impossible. Hence there is no doubt that a means of stopping the leaks and preventing the formation of new annoyances of like nature, will be hailed with pleasure by the average engineer.

The accompanying illustration shows a unique, easy and, to all purposes, practical method of checking the trouble. The



idea is to use an ordinary lubricator, attaching it to the steam main just after it leaves the boiler, in the manner shown in the cut; the pipe from the lubricator (or oil feeder pipe) projecting about one inch beyond the inside edge of the pipe.

An instance where this idea was used to advantage can be seen from the following: The plate in question (Morrison & Cass' Paper Mills, Tyrone, Pa.), has one steam line 450 feet

long, of 16-inch pipe, under a pressure of 100 pounds, and one line of 8-inch pipe, 300 feet long, under 125 pounds pressure.

These pipes are continuously developing minor leaks and it was determined to try the introduction of cylinder oil in the manner above quoted. The first amount of oil used in the long pipe was ½ pint in 24 hours, and in a short time the leakage stopped; after that the amount of oil used was reduced to ½ pint every 48 hours. This amount is kept feeding in continually.

Not only was the introduction of oil found to be of benefit in the matter of stopping the leaks, but it was also found that the pipe was no longer subject to corrosive action of any kind, and a marked difference was at once noted in the ease of the working of the steam traps.

Another feature is that the condensation has also decreased to a marked degree. The stopping of the leaks is caused by the fact that the entire inside surface of the pipe gradually becomes coated with an oleaginous matter which fills up the small crevices upon the inside. To this coating also is due the preservation of the pipe and the decrease in condensation. Almost everyone knows that oil is a very good non-conductor of heat, consequently the film which gathers upon the inside of the pipe acts somewhat in the nature of an inner covering of the most efficient quality. To those engineers having long steam conduity the results promised warrant a trial. It takes but a few minutes to apply the lubricator, and once attached and regulated, it needs no further attention other than refilling the oil chamber of the lubricator. P. J. GRAU.

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The Quality of Oil

Editor PRACTICAL ENGINEER:

While reading J. T. M.'s able article on steam cylinder lubrication, I came across a statement which I think is erroneous.

He says the practice of feeding high pressure oil to both high and low pressure cylinders is wasteful.

Now if the plant is compound surface condensing, and animal oil is fed in the low pressure cylinder, this oil will be carried over through the condenser and boiler to the high pressure cylinder, and, with a temperature of say 350° to 400°, will probably carbonize, lodging in the rings, sometimes sticking them, causing leakage, and, in some cases, cutting the cylinder.

It has been the experience of the writer that enough attention is not given to this property of oil.

At different times the writer has taken air compressors apart and found all the piston rings stuck tight in their grooves and had to be removed with a hammer and chisel.

Of course this is not so liable to occur in a moist steam cylinder, but the tendency towards high pressures and high temperatures is bringing the conditions of steam engines and air compressors more alike every day.

No doubt many steam engineers are handling their first air compressor now, and, if so, I would advise them to insist on an oil that is a pure petroleum product, entirely free from animal fat. If they get this, they will save themselves the trouble of taking the valves out and cleaning the carbon off them, every week or two.

There are too many oil salesmen who are ready to swear that the oil they sell is just right, and the engineer does not find out that it is not right until his valves get sluggish and stick, probably just when the full capacity of the machine is needed. J. D. M.

Education by Mail

Editor PRACTICAL ENGINEER:

In consequence of the fact that the majority of engineers try to earn more by learning more, they have been buncoed repeatedly by so-called correspondence schools, and the writer who has been up against the latest, would warn every member of the A. O. S. E. to thoroughly investigate a school in which the bunco is worked as follows: The writer is a student in a correspondence school having a branch office in Boston in which, when a student, procures a new scholar, he is entitled to a commission in the shape of a due bill.

A short time ago a new student was procured who paid for his course on the $5 installment plan. The writer called at the branch office for above bill and was told to "wait till they investigated." Called again, was told "the solicitor who enrolled the student had failed to turn over the money to the school." Called again, was told "when another student enrolls a new student, we will give you his due bill and let him fuss as much about his money as you have done for yours." In time a due bill on account of a student who had enrolled on the $3 installment plan was sent to the writer, who could not then obtain the larger commission he was entitled to.

There has been a number of cases like this in Boston, so that members of the A. O. S. E. will do well to thoroughly investigate a *school* whose branch offices are apparently being taught to "Bunco by Correspondence."

P. S. Writer's name and address, and name of school, will be given to those interested. Write in care of The PRACTICAL ENGINEER.

The writer of the above informs us that his letter does not refer to the American School of Correspondence, of Boston, but states that several of his friends are students in the latter school and that "they all speak highly of the courtesy shown them as well as of the instruction."—Editor.

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Worth Knowing

MOVING STREET CARS BY MAGIC.—The Interurban Street Railway Company is having a difficult time in its search for a satisfactory motive power for certain cross-town lines. Compressed air failed on the Twenty-eighth and Twenty-ninth street route. The storage battery system, long in use in Thirty-fourth street, seems doomed, because the acid fumes from the batteries have come under the notice of the Board of Health. The under-trolley is barred on these lines by the costliness of the many cross-switches required at the avenues occupied by main lines.

In this period of its tribulation the Company may note with interest the experiments progressing in Chicago with a newly devised method of employing electro-magnets for street car service. The magnets, forming one-half of the motors, are embedded between the rails, and each receives its power from a feed wire. By an alternative arrangement of the magnets as to polarity, the car is attracted through its own armature, and, as it moves forward, it constantly closes the magnetic circuits. Behind the car and in front of it the system is "dead" and devoid of peril to pedestrians or to other traffic.

If the Chicago idea proves to be indeed the practical thing for which the New York management waits, the metropolis may very soon lose its distinction as America's sole city of the lingering horse car.

RUST CEMENT.—A rust joint is made by means of a rust cement, which, as the name implies, makes the joint tight by rusting in place, and filling the space with iron rust. There are several formulas for the cement, all of which have given good service. The following is one of the simplest and best of these: Mix 2 ounces of sal amoniac with 5 lbs. of cast iron borings, and make into a thick paste by adding water. The mixture must be used as soon as prepared. By using only one ounce of sal amoniac the cement will set slower, but will be stronger. The joint is made by ramming the cement into the open space, and allowing it to stand until the rust is formed, and the cement thoroughly set. It is used to cement joints in pipes and fill holes or cracks in iron. It is inexpensive and very serviceable for rough work. This mixture is also sometimes used in setting engines or other machines upon their foundation.—*Science and Industry.*

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To find the horse-power of a boiler find the square feet of heating surface of the shell, heads and tubes, and divide by 15: the answer will be the nominal horse-power.

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Pneumatic Riveting

Machines for riveting with compressed air may be divided into three types. Those which squeeze the rivet, percussion yoke riveters and percussion hand riveters.

The squeeze type is a modification of the well-known hydraulic squeezer riveter and is as effective. By its use we are enabled to do away with one of two costly installations, viz., a hydraulic plant.

The hydraulic plant will cost about five times as much as a compressed air plant, and then after it is finished, the uses to which it can be applied are limited. Whereas, with the compressed air plant we can caulk, chip, drill, tap, ream, expand tubes, bead tubes, cut out tubes and numerous other operations too numerous to mention.

The pneumatic compression riveters are capable of being built in a very compact form. They usually have an air piston of quite large area which is connected with a hydraulic piston of quite small area.

The pressure generated by this hydraulic piston being in turn transferred to the riveting plunger or piston. In this way the enormous pressure is required to close down a rivet and close up the plates or materials at one full stroke.

The smaller of these machines are universally hung, or balanced, which makes them very easy for handling. The larger machines, with great depth of gap, are usually stationary machines. The great disadvantage of these machines is in their weight and clumsiness. The strain being so great that their yokes have of necessity to be made very large, and it is quite impossible to work them in close quarters upon structural or similar work.

The percussion yoke riveters are divided into two classes and each class into two types, the two classes being the valve and valveless tools. Each class having two types, viz., with the fixed and with the pneumatic hold-on. Those with the fixed hold-on are especially suitable for work in which the space at one end of the machine is limited. Especially is this true with structural work. While riveters with pneumatic hold-on are preferable to those in which the hold-on is fixed, for boiler work and heavy work in general. They also have the advantage that the distance from the centre of the rivet to the outside of the case is less, and they are thus able to work much closer to a plate or angle. The valveless class of yoke riveter is a very superior machine and is capable of doing excellent work upon rivets up to and including 1¼" in diameter. It has the advantage of simplicity and but little likelihood of getting out of order. The number of rivets which can be driven in one hour by a machine of this type depending much upon the operator and the amount of pruning which it is necessary to do to make the holes come true.

The valve class of percussion yoke riveters has that great disadvantage which all valve percussion pneumatic tools have. That is the great likelihood of getting out of order, while it will not do any better or faster work than the valve tool. The valve percussion yoke riveter seems to be more prone to getting out of order than do some of the other valve percussion tools.

The pneumatic riveting machine, which has taken such great strikes in the past two years, is the long stroke hand riveter, this being a striking hammer of much longer stroke than the chipping and caulking hammers. The usual length of stroke being 9" and diameter of piston being 1⅛", yet there are modifications of these dimensions. These tools, like all other percussion tools, are divided into two classes, viz., the valve and valveless. But the valveless tool has met with very poor success, and but few of them are to be found. There are many different styles of the valve tool and one is often puzzled to know which one of these to purchase. There are a few Cardinal points which we should watch in purchasing or selecting these tools. Simplicity, ease of holding speed, air consumption, method of holding in the snap. In simplicity we must not only look at the number of parts, but also ease of getting at them. I have in mind an article recently published in regard to the special tools which a tool-room foreman had designed to use in repairing a certain well-known make of these tools. Who wants a hand riveter which requires all of this trouble when a spanner and screw-driver will answer all purposes with several makes? The ease of holding must be tested by a man who is not used to some particular make of riveter. An experienced operator will invariably condemn all tools excepting those which he is used to working with. In making the speed test we must see that our rivets all come to the holes heated alike, that our rivet snaps are all cupped exactly alike, and we must drive at least ten rivets with each tool to be tested, and then take an average of the time required. The same man must handle all of the tools and he must not be too experienced. If he is, do not allow him to run the tool which he is accustomed to.

Air consumption test should be made the same as for chipping hammers. The average consumption for these tools is from 35 to 40 cubic feet of free air per minute, though some of the manufacturers set it much below this mark.

The method of holding in the snap is of the greatest importance. If the snap or die was to be knocked out when the tool was being operated, there would be great danger of injuring the person who is holding up the rivet. Again, time would be lost in picking up the hot snap and getting it into the machine. The partly driven rivet has become so cool that it will be necessary to cut it out, and this requires time. But all of this trouble becomes much worse when the tool is being used upon a high bridge or other lofty structure. Upon a bridge the die is invariably lost, while upon a high building it may be necessary to go down several stories before it can be

recovered. Again, many machines lose out their pistons at the same time as the snap is lost. This cannot be replaced until it is absolutely free from all grit and dirt.

The *Mechanical Engineer*, of one of the largest bridge-building companies in the world, tells me that he figures the loss of snaps and pistons upon field work to be equal to $5.00 per day for each tool in use. Yet he says that these tools earn his company much money.

All different makers of these tools have different methods of fastening in the snaps. None of them are perfect. Some are much better than others. There has recently been placed on the market a device which I consider very superior to all others for this purpose. In this device, it is absolutely impossible to start the tool unless it is pressed up to the work, and, as it is when the tool is not on the work that 95 per cent. of the snaps are lost, this device seems to be nearer perfection than any yet used.

Many people are asking for a percussion machine which will successfully drive cold rivets. All percussion machines will do this up to a certain size, but when we try to drive much above 1¼" in diameter, we immediately run against trouble and the work is never satisfactorily done. And if it outwardly appears satisfactory, there is great danger that the rivets have become crystalized. S. L. HILLS.

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QUESTIONS AND ANSWERS.

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers with questions, he especially desires the readers in such cases to contribute any further information in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communications.

Editor PRACTICAL ENGINEER:

Many times in reading articles in your valuable paper, and others in the same field, I come across so many different technical terms applied to our profession, such as, for instance, the unit of work, the unit of heat, sensible heat, latent heat, specific heat, indicated horse-power, net horse-power, initial pressure, absolute pressure, terminal pressure, mean effective pressure and a number of like expressions.

I do not want to appear ignorant in the eyes of my brother-engineers, yet I know there must be many to whom a short article, explaining in an explicit, if short manner, some of these terms, would be valuable. Respectfully yours,

J. B.

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Definitions of Technical Terms

The many terms, generally used in connection with the study of steam engineering, are all measurable; each with some established unit, and by which they are clearly defined, and their correctness recognized. Many of these are indespensable to the engineer, a few of which are here briefly described and explained as follows:

The "unit of work" is equal in amount to the power required to lift one pound, one foot high, and is called the foot-pound.

The "unit of heat," or thermal unit, is the quantity of heat necessary to raise the temperature of one pound of water, one degree, or from 39 degrees to forty degrees Fahr., as an example.

Also, one unit of heat is equal to 772 foot pounds or units of work. The sensible heat, of any body, as air, water or steam, is the heat that is sensible to our touch, and in extent is as shown by the thermometer.

The "latent heat of steam" is the quantity of heat (expressed in heat units) required to vaporize water that has previously been heated to a temperature equal to the resulting steam of vaporization.

"Specific heat" is the quantity of heat necessary to raise one unit of weight of the substance, through one degree of temperature, measured in thermal units.

"Saturated steam, or dry steam", is steam confined under pressure in contact with the water from which it is formed, and contains just sufficient heat to maintain the water in a state of steam, and will vary in pressure and density corresponding to varying temperatures. When saturated steam suffers loss of heat, a condensation of some of the steam also takes place.

"Superheated steam" is steam containing an excess of heat. Take saturated steam, and more heat be added, its temperature will increase, and the steam is said to be superheated, because its temperature will be greater than that corresponding to saturated steam of the same pressure. This excess may be parted with, without condensation.

"Horse-power" (H. P.) is the standard used for measuring the power of a steam engine, and is equal to lifting 33,000 pounds one foot high in one minute of time, or 550 pounds in one second, or any equivalent thereof in opposition to the force of gravity.

"Indicated horse-power" (I. H. P.) is the horse-power of an engine as computed from the Indicator Diagram.

If the mean area of the piston be multiplied by the mean effective pressure exerted against it, and also by its speed in feet per minute; this product on being divided by 33,000, will be the indicated horse-power of the engine.

"Net horse-power" is the indicated horse-power of an engine, less the horse-power which is consumed in overcoming its own friction.

"Boiler pressure" is the pressure above atmosphere, or the pressure as shown by a correct steam guage.

"Initial pressure" is the pressure in the cylinder acting against the piston, at or near the commencement of the stroke of the engine.

"Absolute pressure" is the pressure of the steam calculated from absolute vacuum. It is the pressure as shown by a steam guage, with the pressure or weight of the atmosphere added thereto.

"Terminal pressure" is the pressure above the line of absolute vacuum that would exist in an engine cylinder, provided the release of the steam had not taken place until the end of the stroke had been reached.

Usually the release happens earlier, and in such case its position may be located by continuing the expansion curve by hand from any point of release, to the end of the diagram.

The terminal pressure must always be measured from the vacuum line; consequently it is the absolute terminal pressure.

"Mean effective pressure" (M. E. P.) is the average of all the varying pressures at different parts of the stroke, exerted

against the engine piston to impel it forward; less all the pressure that acts on the opposite side of the piston to retard its progress.

"Back pressure line," in a non-condensing engine, represents the loss that occurs, from the retardation of the escaping steam, due to atmospheric or other pressure. It is indicated on the diagram by its height above the atmospheric line, and is expressed in pounds per square inch.

On the diagram of a condensing engine it is indicated by its height above a line drawn by hand to represent the pressure in the condenser.

"Total back pressure" is represented on the diagram by its height above the line of absolute vacuum.

"Initial expansion" is the fall of pressure along the steam line, which often happens in an engine cylinder, between initial pressure and the point at cut-off.

"Compression" is a result caused by the action of the piston in compressing into the clearance space all steam remaining in the cylinder after the exhaust valve closes.

"Clearance" is all of the space, or waste-room, between the piston end of its stroke, and the face of the valve.

Its volume or amount is usually expressed in its percentage of the piston displacement.

"Piston displacement" is the distance passed over by the piston in traversing a single stroke.

Its volume is equal to the area of the piston in square inches, multiplied by the length of stroke, in inches; the product is the volume of displacement in cubic inches.

"Wire-drawing" is a term sometimes applied to the action of steam, and arises in consequence of very restricted steam passages; also dilatory valve motion, thereby reducing, more or less, the pressure in the engine cylinders, and usually considered to be a loss in the matter of economy.

"Valve-lap" is the excess of length of the valve at each end, (when at the middle of its stroke) over the extreme outer edge of the steam ports, and is designed to serve as a cut-off valve within certain limits.

"Valve-lead" is the amount of opening of the steam port (permitted by the valve) for the admission of steam to the cylinder, just before the piston arrives at the extreme end of its stroke, the entering steam thereby serving as a cushion for the reciprocating parts of the engine.

"Water, or steam consumption" is the amount of steam accounted for by the indicator, per horse-power per hour, and is a measure of the economy of the engine.

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Editor PRACTICAL ENGINEER:

I will shortly take a position where it will be necessary for me to run a Westinghouse engine, and as I know nothing of its method of operation or construction, I take the liberty of asking you to give me a general description of the same.

A Reader.

The Westinghouse engine is a single acting, high speed, vertical engine; it is an automatic cut-off and not a throttling engine.

The Westinghouse is built in three different styles, the "Standard," the "Junior" and the "Compound," which all embody the main features peculiar to this type of engine, differing only in details. Hence a description of one will answer for all, in the main.

The Westinghouse Standard Engine consists of two vertical cylinders bolted to the top flange of a cast-iron casting, which acts as a pedestal for the engine and also a receptacle for the lubricant, which consists of a mixture of oil and water, into which the moving parts dip at every revolution. The pistons contained in these cylinders are acted upon by the steam from the top only, while at the bottom, which is open, they carry a wrist pin which engages one end of the connecting rods. The other end of the connecting rods act upon a common shaft with cranks set 180 degrees apart; there is no piston rod, stuffing box, cross-head or guides, the connecting rods and cranks being the only links used for transforming the reciprocating motion of the piston into the rotary motion of the shaft.

In the smaller engines the cranks and shafts are forged in one piece, while in the larger units the cranks are forced on the shafts and keyed. The main bearings are lined with Babbitt metal, and are supplied with a wiper, which takes up the oil which may have worked its way past the bearings and returns it to the crank case. An additional bearing is provided near the centre of the shaft for the purpose of relieving the shaft of the strain produced by the thrust of the pistons.

The valve, which is of the piston type, is placed in the Standard engine, in an oblique position between the pistons, the parts being so arranged that steam is admitted alternately into the two cylinders. The valve receives its motion from an inertia shaft governor placed between the cranks, which depends for its action upon the inertia of two weights counterbalanced by spiral springs, so arranged that when the speed increases, the throw of a loose eccentric, and hence also the travel of the valve is reduced. The governor has no novel features, and it works under the disadvantage, shared by all governors of this class, that the compression and release are altered with the cut-off.

The "Junior" engine differs slightly from the "Standard" in design. The governor is placed in the wheel outside of the casing, and the valve chest is placed horizontally over the cylinders, instead of between them. In the Compound Engine the high and the low pressure cylinders (each single acting) are placed side by side. The general design, however, and the method of lubricating are the same in all. These engines are adapted for a variety of uses. They are especially valuable in locations where the engine is exposed to dust, since the working parts are almost completely enclosed in the casing. Its high speed and close regulation make it useful also for electric lighting and railway service, although it is not nearly so economical in the use of steam as many of the types of engines which are used for this purpose.

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Profitable Uses for Liquid Fuel

Every day the question arises more and more persistently from the lips of the steam-users, large and small, "What shall we do to lessen the cost of fuel?" This is an ever-recurring question, more forcibly asserting itself at this time because of the great labor war now going on in the coal fields. But at all times it is a question looming prominently in the eyes of the steam-producer.

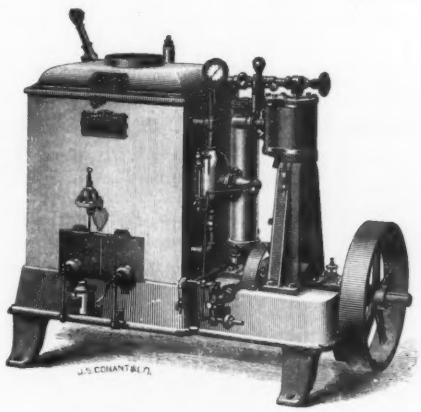
Since the recent and daily continuing discoveries of oil, in various parts of our country, an answer to the above question has arisen—"Use oil as fuel." There is no more alluring project to be presented to the manufacturer just now than a simple and effective means of burning this fuel, without mak-

ing the cost of the charge exorbitant. Recently, many different types of burners have appeared upon the market, but like many other things, they have been made up in a hurry because the availability of oil as a fuel seems to have burst upon us in a like manner. But, a word of caution is here interposed, "Rome was not built in a day," neither has the successful oil-burning appliance been perfected in a week

or two; such things, like everything of real valve, require experience, and such experience as is demonstrated by the use of the appliance under the manifold conditions which a burner is subjected to in operation.

Probably one of the most effective burners now upon the market is shown in the accompanying illustrations. The method used is that of atomizing the oil by either steam or compressed air into a suitably arranged fire-box. The Columbia Crude Oil Burner and Air Injector, as it is called, is manufactured by the Shipman Engine and Boiler Co., 212 Summer Street, Boston, Mass.

This burner is manufactured in sizes to conform to the re-



quirements of any style, type or size boiler now in use, and is the direct outcome of years of experience in the manufacture of oil-burning appliances as applied to marine boilers. At the present time, a great portion of the oil-burners now in use upon steam vessels, both in this country and abroad, are of the above named manufacture.

This type of burner does not require great special, or expensive alterations, in the furnaces in making the change, as the elements required for the complete and economical combustion of the oil is provided for in each appliance. Another good feature of this method of burning oil is the total elimination of all danger of "back lash" of flame from the fire-box.

Figure No. 3 shows a three horse-power engine and boiler complete with oil-burning attachment and the feed-water pumps arranged to operate automatically; it will be noticed that the whole is arranged on a single base plate. They are arranged thus so that they may be readily moved from place to place without making a disconnection, of any of the working parts.

This style of engine has been found to be very effective and economical in the operation of air compressors, turn-tables and draw-bridges, especially the latter, the automatic appliances maintaining a fixed head of steam without waste of fuel and doing away with the dirt, etc., attendent upon the use of coal.

Oil, of course, is not always a cheaper fuel than coal, but with the constant increase of the supply there is a bright future for this method of firing, and, at the present time, it has so many points to recommend it, especially where light power is required, that it is becoming daily more popular for such purposes,

* * *

Books and Publications

Alternating Current Machines; Second Volume of Dynamo Electric Machinery; Its Construction, Design and Operation.

A Text Book for Use in Technical Educational Institutions. By Samuel Sheldon and Hobart Mason.

The D. Van Nostrand Company, 23 Murray Street, New York. Price, $2.50.

This work is designed for use as a text book in technical institutions, and for engineers, not familiar with the subject of alternating currents, but with a previously acquired proficiency in mathematics.

The authors introduce the work with a definition of an alternating current, frequency, phase, units of measurement and their derivation.

The second chapter deals with self-induction and its effects.

Chapter III treats of capacity; condensers and the various methods of combining the same; phase relations; current and voltage relations, etc.

Chapter IV is a series of problems on alternating current circuits.

The next four chapters are devoted to the construction, principles of operation and behavior of various types of American alternating current machines. The last two chapters deal with power transmission and methods of testing circuits and apparatus.

A thorough understanding of the alternating current and its numerous applications is not to be easily acquired, but the able manner in which the subject is handled in this work materially reduces the difficulty of mastering the relation existing between power, electro-motive forces, currents and their phases in series or multiple alternating current circuits containing resistance, capacity and inductance.

The work is by no means elementary in character, but on the contrary demands on the part of the reader a previous knowledge of electricity and mathematics, and will be found a valuable addition to the literature on alternation currents.

TRADE NOTES

James McCrea & Co., 67 W. Washington St., Chicago, manufacturers of steam specialties, have added to their list of agents John B. Adt, Baltimore and Western Supply Co., St. Paul, Minn.

All their agents carry a complete stock and are in a position to fill orders promptly, thereby saving expense and delay of sending direct to the manufacturers.

A Free Sample Bar of Stephenson's Belt Dressing will be sent to any engineer who writes for it and mentions this paper. The manufacturers are anxious to do this in order that all engineers may have an opportunity of testing the merits of their dressing by actual use. Address, the Stephenson Mfg. Co., Albany, N. Y.

Flue Brushes and Piston Packing are two articles that play an important part in the every-day life of most stationary engineers, and often add to his joys or sorrows by decreasing or increasing his labors. The Pilley Packing & Flue Brush Mfg. Co., 308 North Main Street, St. Louis, have just purchased a large six-story building exclusively for the manufacture of these two specialties, which seems to indicate that they have succeeded in giving engineers satisfaction. If any of our readers are having trouble, they should write them for catalogues, prices, etc.

For the Susquehanna Iron & Steel Co., new plant at Columbia, Pa., the Pittsburgh Gage & Supply Co., Pittsburgh, Pa., will furnish three 250 H. P. water tube boilers.

The Pittsburgh Gage & Supply Co. here recently closed contracts with the National Steel Co. to furnish a complete White Star filtering system for a vertical cross compound blowing engine; also filtering systems for the Electric Department of the Carnegie Steel Co., Homestead Works and the Wheeling Steel & Iron Co., Wheeling, W. Va.

William F. Ruwell, the well-known machinist and expert on engine and ice-machine repairs, of 921 Ridge Ave., Phila., has recently found it necessary to work a good portion of the time, both day and night, so busy is his shops with work.

Special Castings are not the easiest thing in the world to get made just now owing to many of the foundries having more than they can do. Therefore, if any of our local readers want special castings made for any purpose, they should apply to the E. J. Moore Machine and Foundry Co., 2227 Wood St., Philadelphia, who have just opened up a large addition to their foundry, and are now ready to take orders for any sized castings.

The Lunkenheimer Co., Cincinnati, Ohio, have issued a new edition of their catalogue, containing 208 pages, and describing and handsomely illustrating the hundreds of specialties in steam goods which they manufacture. These include valves of every description, and for every kind and condition of service, including three way cocks, with relief and corner valves for indicator attachment, brass whistles in endless variety, an automatic cylinder cock for slide valve engines and pumps, stop cocks, water gauges, pressure and vacuum gauges, injectors, automatic lubricators and oil and grease cups for every service.

This is a revised edition of their catalogue of 1898, and shows several changes in the list prices. Copies will be mailed free to any one interested.

College Degrees for Correspondence School Students.—The American School of Correspondence has recently made an arrangement whereby their students are admitted to the classes of one of the great resident technical schools without further examination, and their work counts towards a degree of B. S. This shows the wonderful advance in the standard of correspondence work in the past few years, and marks a new era in the educational possibilities of the common people. Ambitious young men who are too poor to give up four years to obtain a college degree, can now do part of their work at home, and, in this way, finish with a few years at a resident technical school. In this connection the Free Scholarship withdrawal announcement of the American School in another column is of great interest, for it ends one of the greatest educational opportunities of the year. The Trustees of the American School of Correspondence, Boston, Mass., have been offering a limited number of Free Scholarships to deserving young men for the purpose of securing a few representative students in the large shops. The School now announces that after September 30th no more Free Scholarships will be awarded. This is a wonderful opportunity for a bright young man to get a course in Mechanical, Steam, Textile and Sanitary Engineering (including Heating, Ventilation and Plumbing) and Mechanical Drawing. Tuition to successful applicants will be entirely free, the only expense being (as in all schools) for postage and instruction papers.

A postal card, addressed to the School, will bring any information that may be desired.

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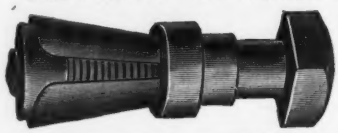

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IF ENGINEERS will send $1.00 to the address below they will receive two blue prints, with tables and instructions, showing how to set valves and eccentrics on Corliss engines, simple and compound, with one and two eccentrics. JOHN T. LINDSTROM, 440 Liberty Street, Allentown, Pa.

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The Power Improvement Co., Room 118, Heed Building, 1215 Filbert St., Phila., have arranged to represent the Larkin Metallic Packing Co. in Eastern Pennsylvania, Delaware, Maryland and New Jersey for the sale of their self-lubricating metallic piston rod and valve stem packing. This packing is adapted for use in any size or style stuffing-box, and may be removed and re-applied at will, the makers claiming it to be practically indestrucible.

One of the Busiest places in Philadelphia today is the Metallic Packing Works of Thomas Walker & Sons, 4619 Tacony St. These works have grown from year to year until at the present time they represent an ideal "hive of industry," and, to use their own words, "Still the orders come," which is the best possible proof of the value of their packings.

The Time is Coming, when the cold weather comes along, and increases your condensation, you will probably need both separators and steam traps, in anticipation of which you should get posted by writing to the Direct Separator, 200 Marcellus St , Syracuse, N. Y., for a catalogue.

The Perfecto Gas and Gasoline Engine Co., with works at Boston and Kensington Avenues, are building an apparently excellent gas or gasoline engine, in sizes from one to fifty horsepower, at a very moderate cost. Any of our readers desiring such an engine should write them for further particulars.

Many Engineers, who have changed from hard to soft coal, find their grates unsatisfactory. Before changing, you should consult Chas. Robson, Eight St. and Washington Ave., Phila. Mr. Robson is an extensive manufacturer of various styles of grates, and his opinion as to the proper type to suit any particular case, is worth having.

Water Purification. — Keystone Tri-Sodium Phosphate is claimed by the manufacturers to be the only known chemical that will, with or without heat, immediately change all hardenable carbonates and sulphates of lime, magnesia, and other incrusting minerals into unhardenable phosphates and absolutely neutralize the carbonic and sulphic acid released by decomposition, producing a clear, soft, harmless water. From the fact that water hardens and boiler incrustation results from the presence of these minerals, the value of this chemical as a water purifier is beyond question. The firm is daily in receipt of letters from manufacturers in all bad water districts of the country, urging them to give wider publicity to their product, and offering to recommend it to all who have trouble with their feed water. They are issuing a book with a rather unique title, "Worth Knowing," which while not for general distribution, will be sent free to readers of The PRACTICAL ENGINEER. Address, Keystone Chemical Co., Camden, N. J.

Unquestionably the largest plant in the world to-day, devoted exclusively to the production of special chemical preparations for the purification of boiler feed waters, is that of George W. Lord, 2228 to 2250 North Ninth St., Philadelphia. But, it appears that Mr. Lord's ambition is not to be measured by his accomplishments to date, nor the demands of his engineer friends and customers gratified by the maximum output of his already great establishment, for he is now erecting an immense edition, almost as large as his entire original factory which, when completed, will nearly double his present capacity.

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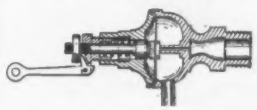
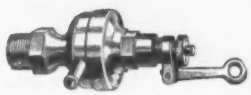


Sectional View

Full View



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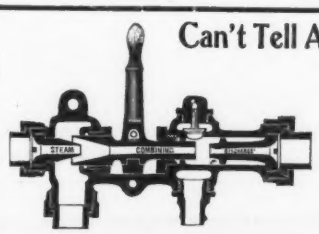

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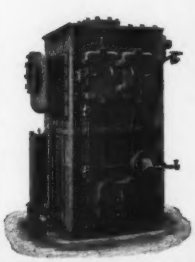

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ORGANIZED APRIL 27, 1886.

An Order of Engineesr for Engineers and Engineers only.

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Believing that ability will bring its full value in this country, this Order shall at no time take part in strikes, nor in any way interfere between employer and employees. Recognizing their identity of interests, it shall take no part in any project or enterprise that shall interfere with perfect harmony between them ; neither shall it be used for political or religious purposes.

These principles shall not be amended or repealed except by unanimous vote of the Order.

Any member who shall be guilty of violating the principles of the Order shall be expelled.

OBJECTS.

First.—To promote a more thorough knowledge in its members of theoretical and practical steam engineering.

Second.—To assist members to obtain employment.

Third.—To help the sick, injured and distressed and bury the dead.

Fourth.—To establish a Widows' and Orphans' Fund.

Fifth.—To help members who shall become incapacitated from following the profession to obtain employment suited to their affliction.

Sixth.—To do our utmost to extend the license law throughout the United States.

Seventh.—To establish schools in which our members may study the highest branches of steam engineering.

MEMBERSHIP.

An applicant for membership must be an engineer between twenty-one and fifty years of age, and must be a white male citizen of the United States, of good moral character and be a believer in the Supreme Being, and be free from all physical infirmities.

He must have had three years' service in an engineering department, or if a machinist, or graduate of a technical institute, then, one year's service, in such department, and in localities where engineers are required by law to be licensed, they must have such license, and must satisfy the investigating and examining committees of the council to which he applies as to his character and ability.

LIFE MEMBERSHIP.

Engineers who have passed the age limit may be admitted to life membership. They must possess the same qualifications and pass the same examination as are required in the next proceeding clause: They shall be entitled to all rights and privileges of the Order except they cannot vote on financial questions or for the election of officers or be entitled to any sick or death benefits.

DIRECTORY.

The Publication Committee of "The Practical Engineer" desires that the Corresponding Engineers of all Councils of the American Order of Steam Engineers send the name of their Chief Engineer and their own name and address, together with the time and place of meeting to the Secretary of the Publication Committee immediately after each election of officers. Address J. C. McDowell, Secretary, in care of "The Practical Engineer," 1215 Filbert Street, Philadelphia.

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Energy Council, No. 2, meets every Wednesday of each month in Bauer Hall, Cheaspeak and Elliott Sts. Chief Engineer, Philip A. Kirkwood. Corresponding Engineer, Jos. H. Stallings 3032 Dillon St.

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Orange Council, No. 9, Meets 2d and 4th Fridays. Chief Engineer, Chas. Gartrell; Corresponding Engineer, Fred. L. Hale.

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Old Colony Council, No. 14, meets second and fourth Saturdays in the American Foresters' Hall. Chief Engineer, E. H. Naylor. Corresponding Engineer, James K. Sedgwick P. O. Box, 333, Rockland, Mass.

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Stevens Council, No. 1, meets third Saturday, at Water, near Lafayette Street. Chief Engineer, Lawrence Oliver. Corresponding Engineer, James H. White.

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Bridgeton Council, No. 5, meets every Friday. Chief Engineer, David Sellers. Corresponding Engineer, Francis O. Garrison, Bridgeton, N. J.

Millville.

Millville Council, No. 6, meets every Saturday, 7.30 p. m., in G. A. R. Hall, East Main St. Chief Engineer, Geo. Esabel Corresponding Engineer, Lewis Doughty, 604 Mulberry Street.

NEW YORK.

Syracuse.

John E. Sweet Council, No. 6, meets Monday, Room 23, Nottingham Block, East Washington Street. Chief Engineer, John Cunningham. Corresponding Engineer, S. A. Steel, 311 Orange street.

PENNSYLVANIA.

Grand Chief Engineer, Hiram Trout, 1105 North Tenth street, Reading, Pa. Grand Corresponding Engineer, Frederick Markoe, 931 Orianna street, Philadelphia.

Philadelphia.

Deputy Grand Chief for Western Pennsylvania, A. D. Hamilton, 2025 Forbes Street, Pittsburg, Pa.

Germantown Council No. 22 meets every Wednesday evening at Main and Seymour Streets, Germantown; Chief Engineer, John P. Rickards; Corresponding Engineer, Frank MacIndoe, 3529 Ainslie St., Falls of Schuylkill, Philadelphia.

Welcome Council, No. 2, meets every Friday, N. W. Cor. 12th Street and Columbia Avenue. Chief Engineer, Paul Pieling. Corresponding Engineer, L. D. Woodington, 2428 N. Bancroft St.

Kensington Council, No. 3, meets every Thursday, at A. P. A. Hall, Frankford Avenue and Master St. Chief Engineer David J. Ezrah. Corresponding Engineer, Charles Fournier, 3115 Richmond St., Philadelphia.

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(Continued on page 28.)

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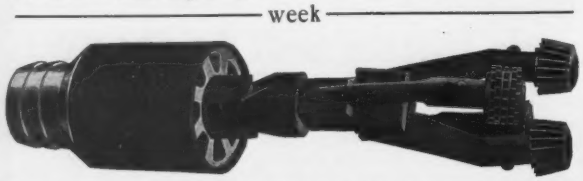

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Helping Hand Council, No. 12, meets every Tuesday evening at Jasper and Huntington Streets. Chief Engineer, Thos. Evans. Corresponding Engineer, Frank McHugh, 2503 Tulip St.

Municipal P. F. D. Council, No. 20, of Philadelphia, meets the second Thursday of each month at Odd Fellows' Hall, Third and Brown Streets. Chief Engineer, Frederick Markoe. Corresponding Engineer, Walter Meyers, 1211 North Howard Street.

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Girard Council, No. 8, meets every Tuesday evening at O'Neill's Hall, 2nd and Ogden Sts. Chief Engineer, Jacob Weber. Corresponding Engineer, M. J. Carey, Lock Box 214.

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Lehigh Council, No. 15, meets every Wednesday evening at 639 Hamilton St. Chief Engineer, Wm. R. Smith. Corresponding Engineer, A. P. Driesbach, 728 Chew Street.

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York Council, No. 16, meets every Wednesday evening in the Jordan Block. Chief Engineer, A. L. Bair. Corresponding Engineer, Walter H. Long, 23 East Philadelphia Street.

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Columbia.

Columbia Council, No. 18, meets every first and third Saturdays, in Odd Fellows' Hall. Chief Engineer, Ruben Beard. Corresponding Engineer, W. J. Courtney, 804 Walnut Street.

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Sunbury Council, No. 19, meets every second and fourth Saturday in Zartman's Hall. Chief Engineer, S. E. Lees. Corresponding Engineer, Ed. Schrieber.

WISCONSIN.

Deputy Supreme Chief Engineer, Joseph P. Harris, No. 1611 Clybourn Street, Milwaukee.

Milwaukee.

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Clifford P. Williams Council, No. 2, meets every Thursday evening 298 4th Street. Chief Engineer, David T. Richardson. Corresponding Engineer, Jas. T. Harris, 1611 Clybourn Street.

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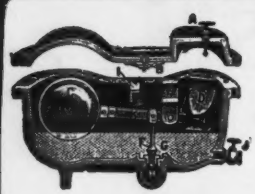

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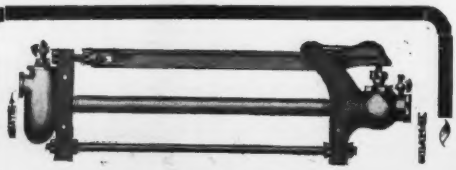

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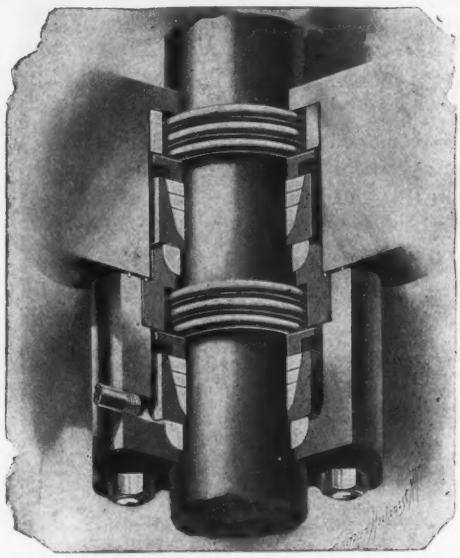

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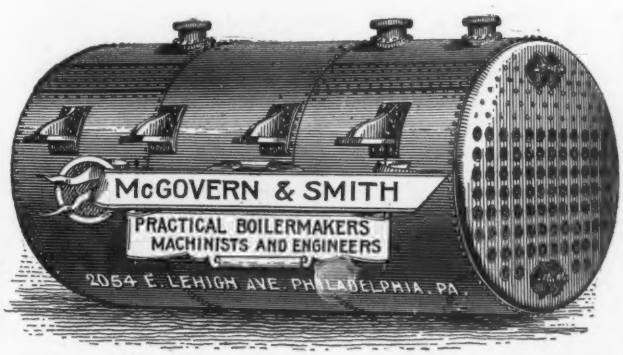

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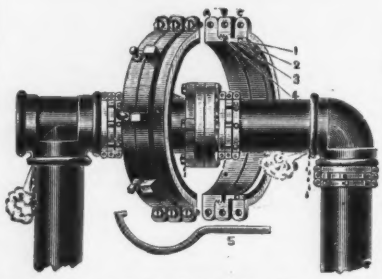

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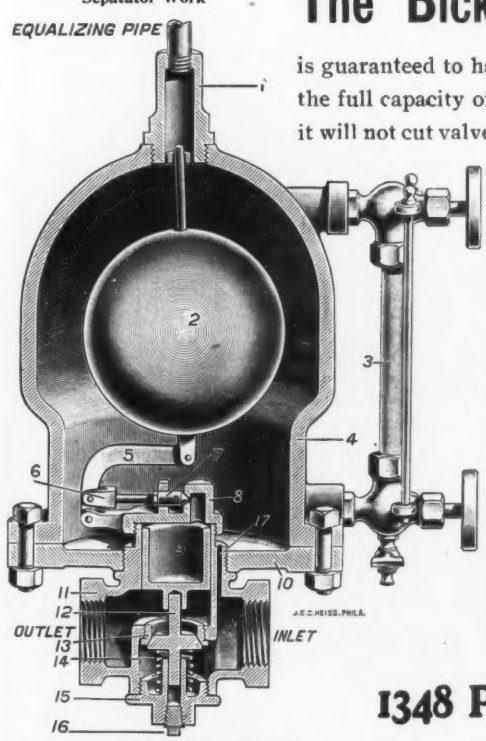

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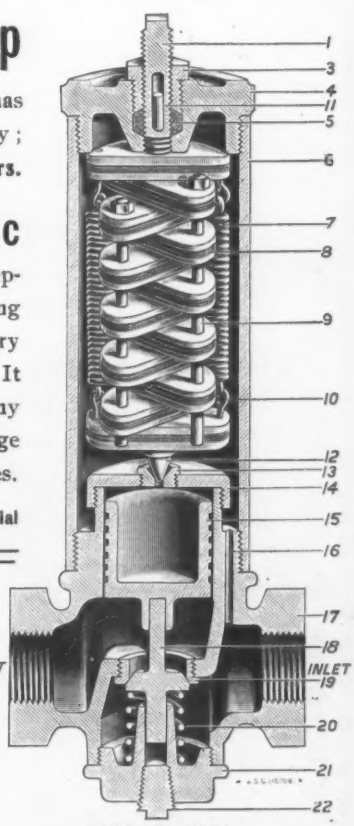

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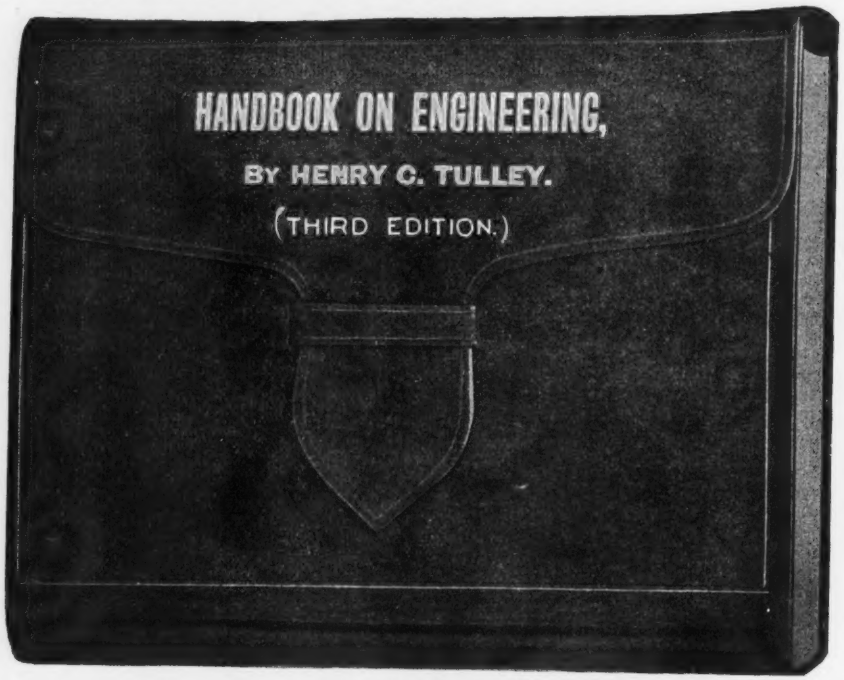

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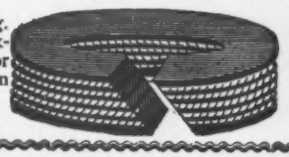

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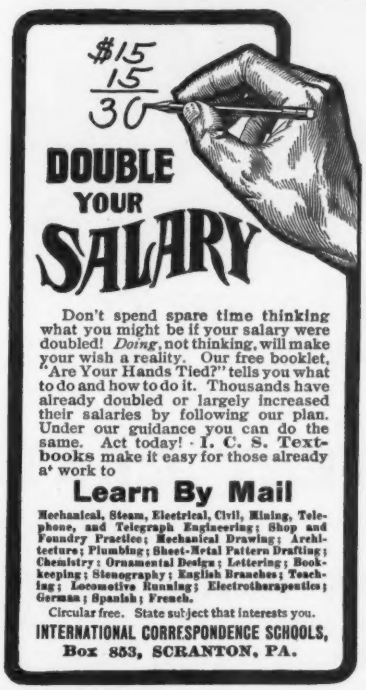

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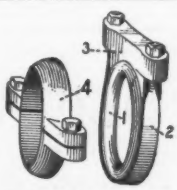

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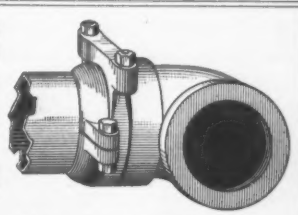

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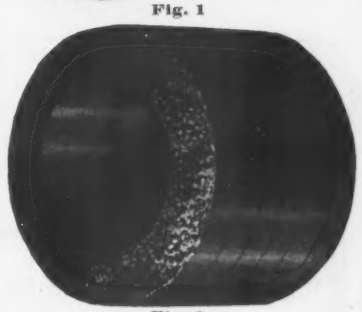

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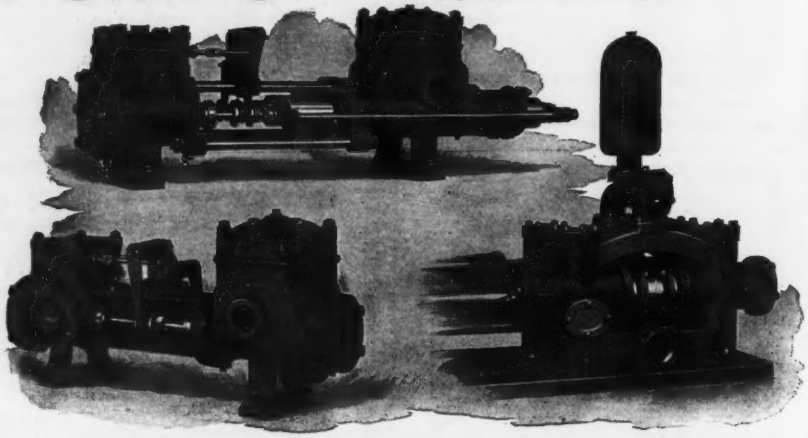

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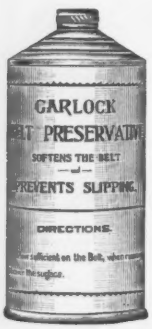

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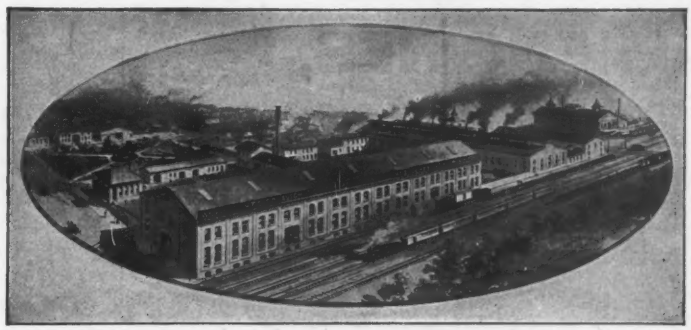

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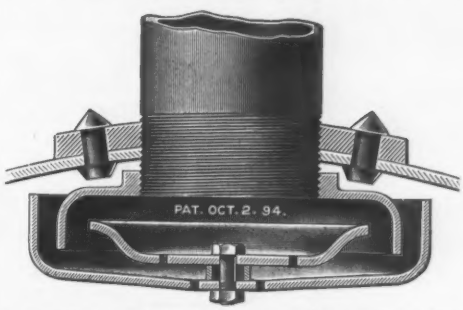

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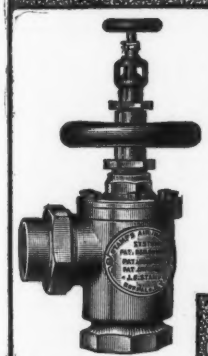

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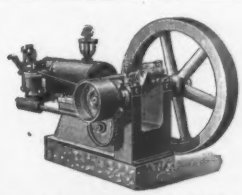

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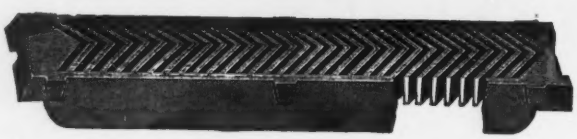

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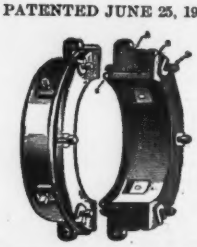

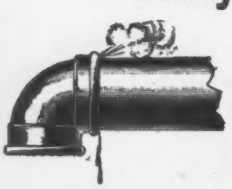

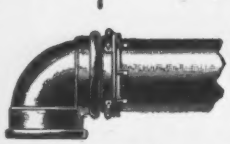

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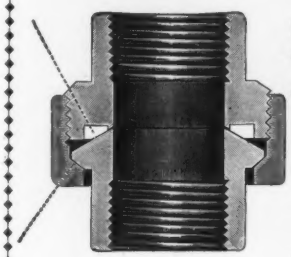

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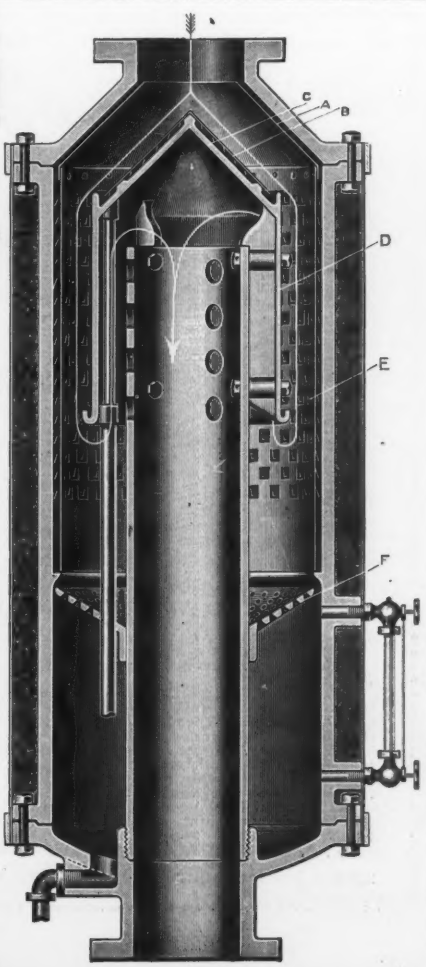

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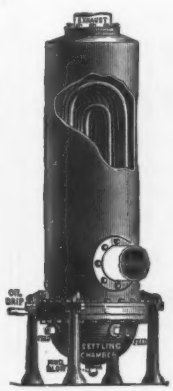

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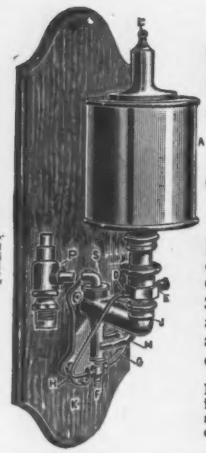

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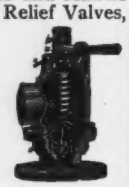

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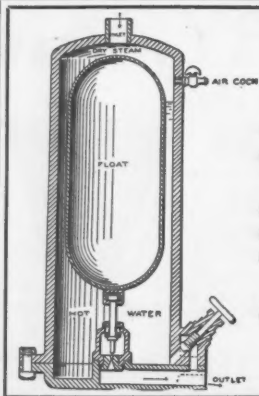

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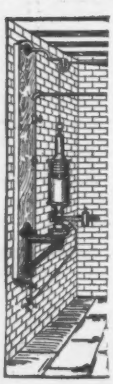

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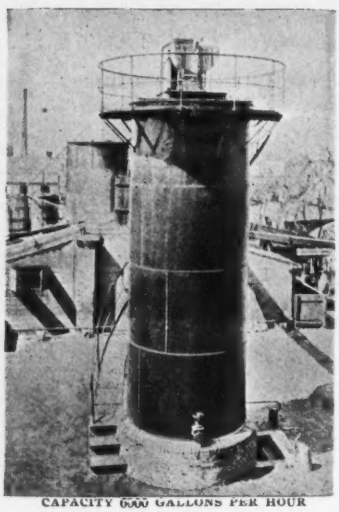

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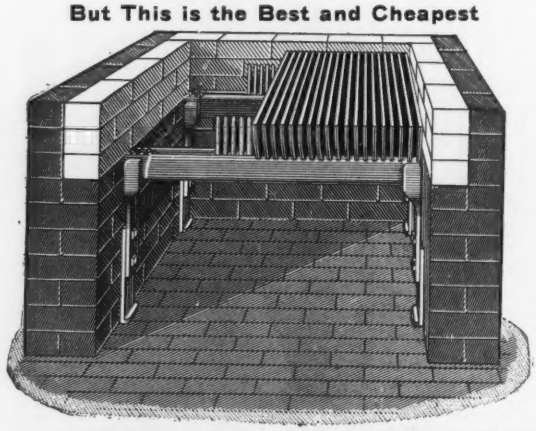

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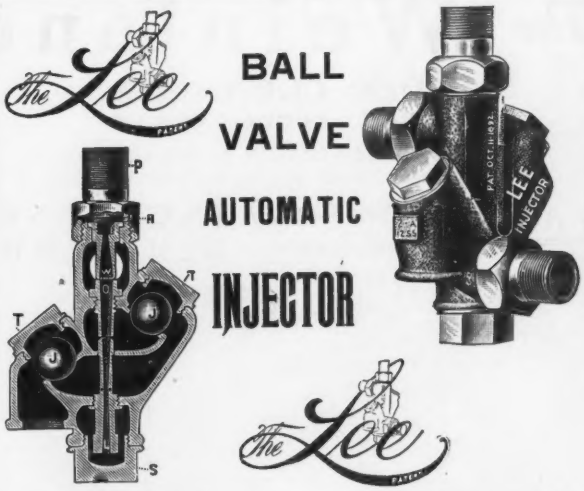

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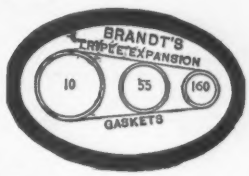

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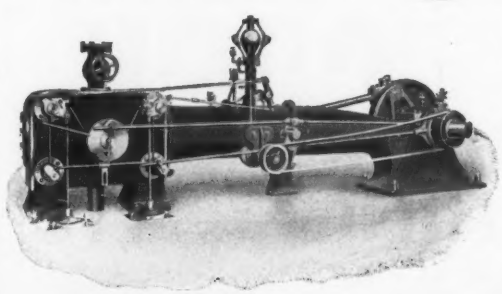

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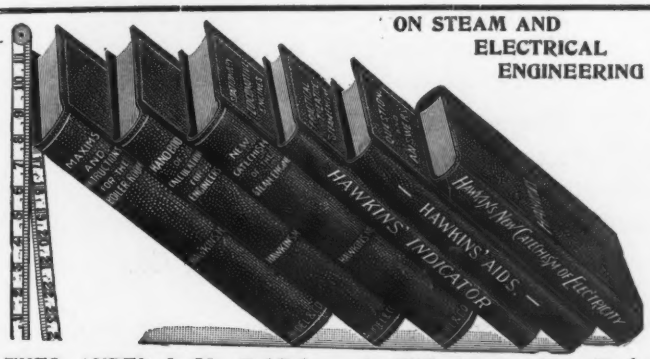

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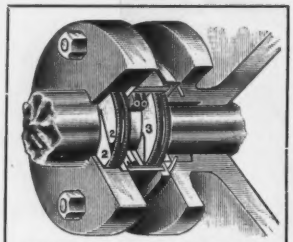

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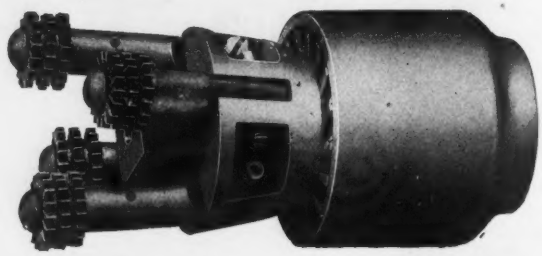

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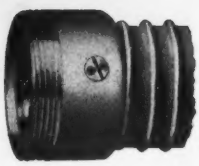

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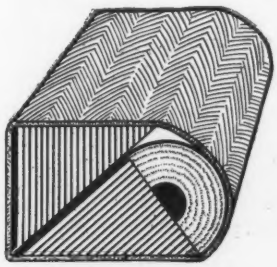

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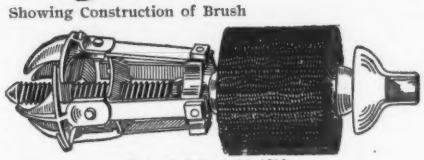

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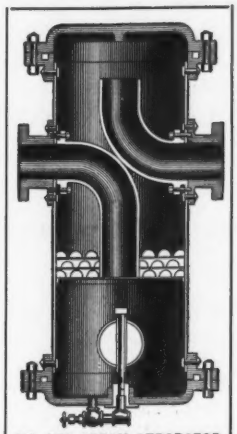

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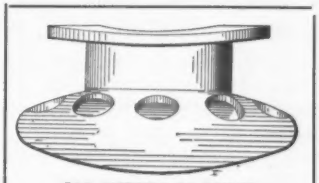

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PREFACE

The preparation of this book has occupied most of the author's spare time for a number of years. Originally the matter was not intended for publication, but the manuscript has grown so large and complete, which consideration, combined with many repeated requests, has induced the writer to publish the matter in book form.

Let every engineer make his own indicator book as he proceeds in his study and practice, and it will prove invaluable in after years. The present work has been compiled in this way, from data continually obtained during the author's professional career, extending over a third of a century.

The introduction of algebrical formules have been avoided. These are readily found in the many valuable mechanical pocket books. The writer has endeavored to discuss the principle and use of the indicator in as plain common sense words as the subject and the English language will admit of

Special attention has been given to the requirements of the young progressive student in steam engineering. The preparation of the following chapters has been a work of pleasure to the author, and if they prove beneficial to his fellow-workmen, he will be amply repaid.

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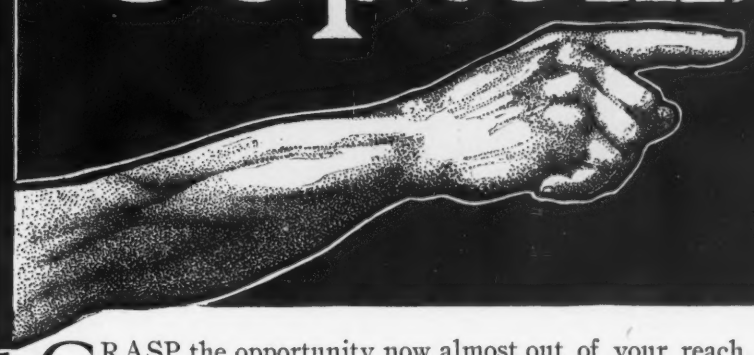

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How long do you keep it open?.....

Name the river or source of your water supply.....

Does the feed-pipe clog up or form scale?.....

Do you use a heater?.....

Do you run day and night?.....

If samples of scale are sent in separate packages, please mark same with your name and address.

Your name.....

Address.....

Firm name.....

Mail this to

GEO. W. LORD

2238-50 N. 9th St., Philadelphia, Pa.

SOLE MANUFACTURER, LORD'S BOILER COMPOUNDS

TRADE MARK

BOILER SCALE

REGISTERED

THE CAUSE OF 90 PER CENT. OF ALL BOILER TROUBLE

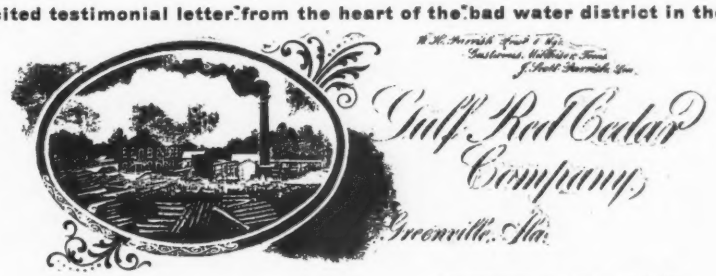
THE REMEDY

KEYSTONE

TRI-SODIUM PHOSPHATE

READ THIS

Unsolicited testimonial letter from the heart of the bad water district in the South.



GREENVILLE, ALA., 8-6-02.

KEYSTONE CHEMICAL MFG. CO.,
CAMDEN, N. J.

GENTLEMEN:—

We have your favor of the 4th inst. Your prices on your Keystone Tri-Sodium Phosphate are all O. K. We also wish to say you may use our letter as a testimonial, as the market is so full of frauds in the way of boiler compounds, that when we get hold of a good boiler compound, we feel like letting our friends know it. Yours very truly,

GULF RED CEDAR CO.

Manager

Like all good things Keystone Tri-Sodium Phosphate is imitated, therefore remember the

TRADE **KEYSTONE** MARK

NONE OTHER GENUINE

TRADE MARK

REGISTERED

TRADE MARK

REGISTERED

Keystone Chemical Manufacturing Company,

Camden. N. J.

HOUGHTON'S MONTHLY LETTER TO ENGINEERS

DEAR MR. ENGINEER:

We want to write something about cylinder oils in general and VIM Cylinder oil in particular.

Something you can understand.

We know that not one engineer in a thousand understands the average cylinder oil man's talk or literature.

We know the cylinder oil man seldom understands it himself.

The question is:

Why should you use Vim Cylinder Oil?

Will it last longer than what you are using?

Possibly not.

Certainly not, if you are using a common cylinder oil full of tar or residuum.

Residuum makes cylinder oils last, but it prevents their lubricating.

VIM Cylinder Oils are not made to last longest; they are made to lubricate best.

By lubricating best, we mean, that they reduce the friction to the lowest minimum and, consequently, reduce the troubles arising from excessive friction, such as softening of the metal of the cylinder, misplacement of the valves, etc., as well as cause a saving in fuel.

The best proof of the superiority of VIM Cylinder Oils is the fact that engines which have been lubricated consecutively with them for years show no perceptible wear, while the engines which have been lubricated with every Tom, Dick and Harry's oils have been re-bored, replaced or thrown out.

But the oil seldom gets the blame for this.

The engineer is the one who has to shoulder the trouble every time.

This injures his reputation.

Injury to his reputation means a decrease in wages.

It is the engineer who has the pluck to stand up and demand the oil that is best for his own interests, and much better for his employers interests, that has the good, steady jobs.

Employers think all the more of an engineer who stands up for what he knows is right.

The scarcest thing that an employer can obtain is brains and judgment; and they are always willing to pay high wages to get them.

They can get a valve turner or a coal shoveler cheap.

And your knowledge is worth nothing to the employer, unless you use it.

The question is, whether you have the pluck to stand right up and say:

Mr. Boss, I want to use Vim Cylinder Oils on my engine. I know it will cost more than the oil that I am using, but I am equally positive it is worth the difference. It may not be as convenient to purchase, but I find that the case with all high grade materials. It is only the common inferior goods, which price alone sells, that are appreciated by the majority and are handled by every dealer. Our engine is a good one; I am competent to operate it with the minimum danger of a shutdown; but I ought to have materials which I know will aid my own skill, and not the least important of these is a cylinder oil that has been on the market longer than others, and one in which all engineers have confidence.

Now, these are the lines on which you have to talk. Your employer may kick, frown and look disagreeable when you are present, but when you leave he will say:

"I like that fellow, he has ideas of his own."

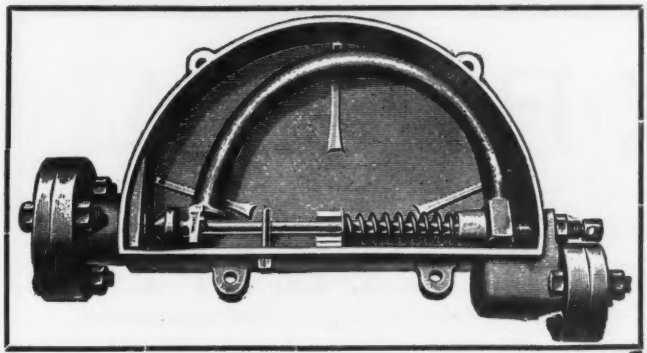
Just think this over and see if we are not right.

Yours respectfully,

E. F. Houghton & Company

240-250 W. Somerset Street PHILADELPHIA

175 - 177 Lake Street CHICAGO



A Good Rule

IT was a wise man, who, when a young friend asked him what kind of machine to buy, answered, "The kind that is most imitated."

The HEINTZ Steam Trap is one of the easiest things to imitate—in appearance; and as it has a great reputation and wide sale, the market is full of traps exactly like it—outside, Its marvelous efficiency is due to the fact that the liquid that actuates the tube spring is so sensitive to heat that it moves quickly and with great force on a variation of LESS THAN ONE DEGREE of temperature.

And that liquid has never yet been successfully imitated.

Don't trust appearances. Remember the name—HEINTZ.

The HEINTZ Steam Trap is made in nine sizes; capacity 1 to 240 gallons a minute. Any size sent on 30 days' trial; no charge unless satisfactory. Guaranteed for one year.

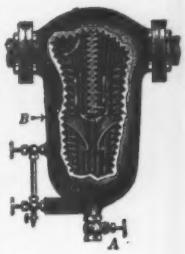
WILLIAM S. HAINES CO.

136 SOUTH FOURTH STREET

PHILADELPHIA

(HF)

POWER costs all that it costs to produce it, plus all that is wasted. A very constant cause of waste is removed by the HINE ELIMINATOR which takes the water out of live steam and oil out of the exhaust.



The Hine saves more than it costs—always.

AN Improved ROBERTSON-THOMPSON INDICATOR shares the work of the engineer. It helps him earn his pay and gives him good grounds for asking more.

EUREKA PACKING costs less than the next best, and is better than the rest. It's the packing that covers the whole field of *excellence*, *efficiency*, *economy*, *long life*. There's a *red diamond* on the box. Some dealers try to substitute.

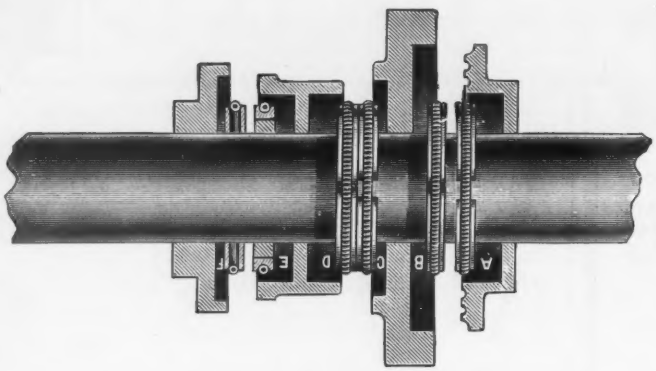
SEND for catalogue of PLANIMETERS, REDUCING WHEELS and other helps to steam users.

OUR little pocket dice box made a great hit with several thousand engineers. It cost us a good deal, but we are willing to send it with the catalogue to any engineer who sends five cents in stamps for postage.

Jas. L. Robertson & Sons. 205 Fulton Street, New York.

Boston Philadelphia St. Louis

WALKER'S

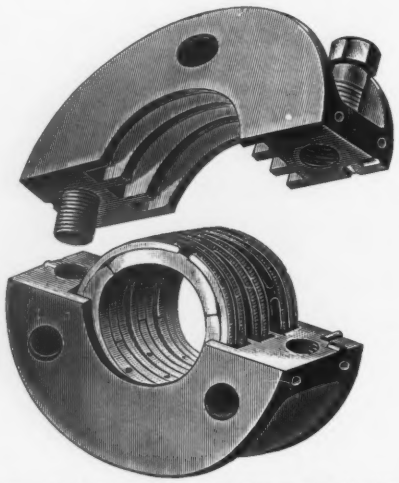


Metallic Packing

Will Last for Years Without Repairs

NO FRICTION NO ATTENTION A GAIN OF POWER

A Look at the Piston Rods will Convince the Most Skeptical
Positively no Cutting — It is Fully Guaranteed
No More Bills for Soft Packing — Will Not Wear Round
Thirty Day's Trial



Recently, other persons have been manufacturing a case similar to the above and offering it for sale. We hereby give notice that we are the patentees and sole owners of Patents covering this case, No. 525,434, issued September 4, 1894.

WE have been manufacturing Metallic Packing for twenty years with absolute satisfaction to our many thousands of customers. There are 100,000 of these packings in use among the largest manufacturing establishments in the world.

This Packing can be applied to engines without disconnecting any part of engine. Perfectly steam tight when working under highest steam pressure, and absolutely vacuum tight.

THOS. WALKER & SONS

4617-21 TACONY STREET - - - FRANKFORD, PHILADELPHIA, PA.

Branch Office: 128 Massachusetts Ave., Allegheny City, Pa.

Drip, Drip, Dripping,

AND WASTING AWAY OF OIL WHEN USED AS A LUBRICANT IS EXPENSIVE, FOR A LARGE PERCENTAGE IS LOST, TO SAY NOTHING OF THE UNCLEANLINESS RESULTING FROM THE DRIPPING

KEYSTONE GREASE

doesn't drip or waste away, it will reduce the friction load to as low a point as the best grades of oil and will last two or three times as long.

It never gums on the bearings and will give satisfaction in any temperature.

There are no disadvantages about Keystone Grease as a lubricant,

compared with oils or other lubricating agents, it is far superior and a great deal more economical.

Will keep in any climate and doesn't spoil with age. Adapted for any kind of machinery, Shafting, Cams, Roller Bearings, Ball Bearings and wherever it is necessary to apply a lubricant to minimize friction.

TO PROVE THAT KEYSTONE GREASE WILL FULFILL EVERY REQUIREMENT OF A PERFECT LUBRICANT WE WILL SEND, EXPRESSAGE PREPAID, A LARGE SAMPLE AND A KEYSTONE GREASE CUP TO ANY PART OF THE U. S. FREE

KEYSTONE LUBRICATING COMPANY

20th AND ALLEGHANY AVENUES — PHILADELPHIA, PA.

KEYSTONE GREASE IS NOT SOLD BY JOBBERS

PLATE I. R. B.

MOORE'S HIGH PRESSURE SAFETY STEAM BOILERS, [800,000] H. P. in use, both in Europe and America

Repairs of Water Tubes. Boilers of all types a specialty. We have special tools for this purpose.
We keep constantly on hand ready for shipment 1000 horse-power. There can be no delay. **Send for Catalogue.**

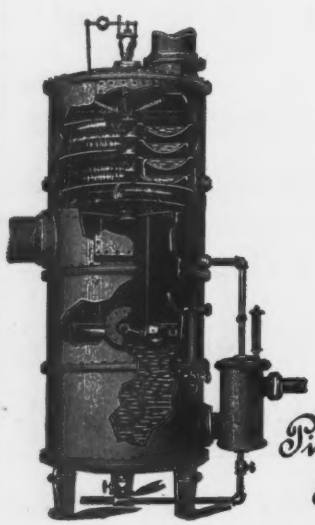
ESTABLISHED 1864 PHONE

E. J. Moore Machine & Foundry Co.

MACHINISTS, FOUNDERS & PATTERN MAKERS

**Gray-White, Semi-Steel Aluminum Alloy Castings. Mills and Pulverizers for Minerals, Cereals, &c.
Stamping and Embossing Presses, Roller Mills.**

2227-2235 WOOD STREET Philadelphia, Pa., U. S. A.



Bonar Gauge Cocks.
Bonar Oil Filters.

Steam Appliances

Pittsburgh Feed Water Heaters.

James Bonar and Co.
Carnegie Blg. Pittsburgh, Pa.

LUNKENHEIMER
VALVES
Lunkenheimer Valves are made in endless variety for every requirement, in standard sizes. in bronze and iron, for medium and extra heavy pressures. None but high grade materials and skilled workmanship enter into their makeup. Subjected to rigid test and inspection before shipment. Specify *Lunkenheimer* make and order from your dealer. Write for Catalog.
THE LUNKENHEIMER CO., Cincinnati, Ohio, U. S. A.
Branches: New York, 26 Cortlandt St.; London, 35 Great Dover St., S. E.
4

We are the Originators, not Imitators

and the general verdict is that

Perry's Red and Brown Sheet Packings

are the only old and original goods now offered to the trade, and that PERRY'S SPECIALTIES in Steam Packings, for all purposes, are made upon honor and have no superiors.

TRY THEM

Manufactured by the **La Favorite Rubber Mfg. Company**

PATERSON, N. J.

'96 Jenkins Standard '96 Packing '96

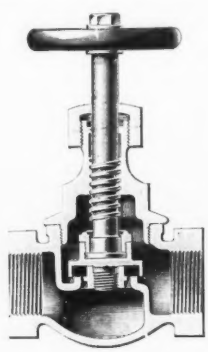
The Perfection of Joint Packing. Do not accept unless it bears our Trade-Mark as shown in the cut.

Use Jenkins '96 Sheet Packing on the worst joint you have, and if it is not what we claim we will refund the money.

JENKINS '96 PACKING has stood the most crucial tests under all conditions of service with steam, oils, acids, ammonia and the like, and in no case has it failed to make a perfect joint when properly applied. Can be placed in a joint either hot or cold, and will make joint instantly. Full steam pressure can be turned on at once when joint is made, it does not require to be followed up and will not blow out. It vulcanizes in place and forms a compound that will not rot or burn out, but will last as long as the metals which hold it. It joins with rough surfaces equally as well as when they are faced. **Jenkins Standard '96 Packing** weighs less than most joint packings. When compared with equal sizes of other packings sold at a lower price per pound, it will be found to cost less per square yard.

Jenkins Brothers' Valves

Design, workmanship and materials of the highest standard throughout. Every valve inspected and tested before leaving the factory. Made in all styles and sizes, both brass and iron.



Jenkins Discs

Do not be deceived when you are offered discs "just as good" or better than the Jenkins, as many worthless imitations of our discs are on the market. We are the original manufacturers of this class of goods, and we have tried to maintain the high standard in which they are held by steam users throughout the world. Copper, lead, Babbitt and all kinds of metal discs have been experimented with for the past twenty years, and in almost every instance, when under the action of steam, they become oxidized and hard, so that chip or scale getting between the disc and seat causes a leak, which necessitates regrinding. Insist on having the genuine Jenkins Discs; the difference in cost will not pay you to experiment. If you wish discs for any particular purpose, write to us; we can experiment cheaper for you than you can for yourselves. **Jenkins Discs will stand steam, oils or acids. We have special soft discs for cold water**

Jenkins Brothers' Pump Valves

Adapted to every pumping requirement, these valves are especially suited for pumping hot water, syrups, beer and other destructive fluids; also muddy and gritty water. When rubber valves have been found useless, these valves have given entire satisfaction.

For mining and high-pressure service, also for elevator pumps, Jenkins Brothers' No. 88 Pump Valves are in use under 450 pounds pressure, and are proving themselves equal to every requirement.

We also manufacture a fine grade of Soft Rubber Valves for cold water and air service.

When ordering valves, please state for what purpose you desire to use them.

Jenkins Brothers' Valves, Jenkins '96 Packing and Rubber Specialties received the Highest Awards at the Pan-American Exposition

All our different specialties are stamped with Trade-Mark

Write for Catalogue

JENKINS BROTHERS'

71 John Street	17 Pearl Street	133 N. Seventh Street	31-33 N. Canal Street	62 Watling St., Queen Victoria St.
NEW YORK	BOSTON	PHILADELPHIA	CHICAGO	LONDON, E. C.